UNITED STATES DEPARTMENT OF AGRICULTU E

BUREAU OF ENTOMOLOGY

FOREST INSECT INVESTIGATIONS

THE PARASITES, PREDATORS, AND ASSOCIATED INSECTS of the MOUNTAIN PINE BEETLE (DENDROCTONUS MONTICOLAE HOPK.) IN LODGEPOLE PINE

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May 15, 1930.

U. S. GOVERNMENT PRINTING OFFICE: 1928 J 76132

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Respectfully submitted

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THE PARASITES, PREDATORS, AND ASSOCIATED INSECTS of the MOUNTAIN PINE BEETLE (DENDROCTONUS MONTICOLAE HOPK.) IN LODGEPOLE PINE

THE IMPORTANCE OF PARASITIC AND PREDACIOUS INSECTS

The part played by parasitic and predacious insects in the control of economically destructive insects is almost always of considerable, and very often great, importance. In the case of the mountain pine beetle the progeny emerging from a tree would be at least two to three times as numerous as its parents that killed the tree were it not for the insects which destroy the immature forms of these beetles. A study to determine what these insects were; the role played by each one, how artificial control could best be aided by biological control of the mountain pine beetle in lodgepole, and what insects were not important, was begun August 1, 1928, in the region of Sula, Montana. The following report is the result of this study.

For the present no further study of the insects associated with the mountain pine beetle in lodgepole pine is contemplated, for though the report is by no means complete, the most important data have been obtained, and economic pressure forces us to begin a similar study with the same objective in view in the white pine type.

A previous report (1) described the habits and life histories of three insects of economic importance: Coeloides sp., Medeterus aldrichi Wh., and Lonchaea viridana Meigen. None of the essentials, except some anatomical details of Medeterus aldrichi Wh. larvae have been omitted from this report that were present in the first; much has been added.

The results of the study show:

(1) That a parasite, Coeloides sp., was the most important controlling agent, and did its best work on the developing beetle brood of Dm* between June 1 and July 6 the season following the Dm attack.

(2) That a predator, Medeterus aldrichi Wh., was second in importance to Coeloides sp. but the species was more abundant in the fall of the year.

(1) DeLeon, D. Introductory Study of the Parasites, Predators, and Some other Associated Insects of the Mountain Pine Beetle in Lodgepole Pine, Jan. 1929.

* Throughout this report the convention has been adopted as a convenience of using "Dm" to represent Dendroctonus monticolae Hopk. When the abbreviation is followed by a figure it means the year of attack; thus Dm 28 Y.P. means a yellow pine attacked by the mountain pine beetle in 1928.

(3) That while many other species feed on the immature stages of the beetle, their individual economic importance as controlling agents was slight, but considered altogether they were of considerable value.

(4) That by instituting artificial control work as soon after the beetle attack as possible natural control by all species will be aided, for the longer the infested tree stands the more numerous become the parasites and predators.

(5) That though many parasites and predators, especially Medeterus, will be destroyed by fall control work, spring control work would destroy more. Besides this, destruction of parasites or predators in the fall is not as serious as destruction of them in the spring since the Dm larvae in the fall have a lower emergence potential than those that have survived the winter and other agencies.

(6) That treatment of infested trees after the middle of May and especially during June destroys practically all of the beneficial insects along with the beetle brood.

The report is divided into two parts. Part I deals in greater detail with those insects that are of economic importance in the control of the beetle, or more common under the bark of the infested trees. Part II lists those insects not mentioned in Part I and gives a note or two concerning the occurrence, size, and general aspects. Though many of the insects described in Part II are predacious, most of them are species which are attracted to weakened trees, or are scavengers, or mycetophagus insects, etc. They are included so that one may be able to distinguish the beneficial insects from those of no apparent importance.

Determinations of the insects mentioned here were made by the following systematists: Mr. Aldrich, Dr. Boving, Dr. Burke, Mr. Chapin, Mr. Cushman, Mr. Gahan, Mr. Greene, Mr. Middleton, and Dr. Van Dyke, to each of whom appreciation is expressed.

PART I

COELOIDES SP.

(Hymenoptera Braconidae)
External Parasite

Coeloides sp. was found to be the most important factor in the biological control of the mountain pine beetle in lodgepole pine.

Adult

Coeloides sp. (Plate 1, Fig. 1e) is a small, wasp-like insect, the female of which is considerably larger than the male. The females, from the head to the end of the body, average 5-7 mm. in length, while the ovipositor is slightly longer than the abdomen. Though generally reddish the abdomen of the female is occasionally black; the male, on the contrary, usually has a black abdomen -- very rarely is it red. The male is considerably smaller than the female, seldom being over 4 mm. in length, and regardless of color or size, can be distinguished from the female through the absence of an ovipositor. In both sexes the head and thorax are black.

There are two distinct generations of Coeloides sp., (Chart I), one of which, the early generation, parasitizes the mountain pine beetle larvae the year of the beetle attack. Those in this group most commonly spin their cocoons in the fall; remain as larvae until May; then pupate and emerge during late May and June. The other, the main generation, however, is by far the more important as a controlling agent of the beetle brood. Fully 95 per cent of the Coeloides sp. parasitizing the larvae of Dm is in this group. In this generation the eggs are laid chiefly by Coeloides sp. from the previous main generation on beetle larvae in June, eight months after the beetle attack. Though the developing larvae spin cocoons after feeding from three to five weeks, most of them remain as larvae within their cocoons until the following spring; they then pupate during May or early June for 10 to 20 days, depending on the sex; transform to new adults, and emerge in time to lay eggs upon the advanced beetle larvae of the previous season's attack.

During the past season (1929) it was found that in the main generation the males emerge before the females. In the field the first male was collected May 21, nine days before the first female, and by May 30 the males were common on Dm 27 trees. Emergence from cocoons collected in the field but kept in the laboratory after collection was as follows, in Tables I and II.

Table I

Emergence from Cocoons Collected May 11, 1929, Spun June 1928.

1929 Emergence	Males	Females	
May 23	1	0	
24	1	0	
25	18	8	
26	30	7	
27	17	31	
28	2	16	
29	1	8	
30	1	1	
31	0	0	
June 5	0	(1)	Hyperparasite (Eurytoma)
Total	71	71	

Table II

Emergence from Cocoons Collected June 7, 1929, Spun June 1928.

1929 Emergence	Males	Females	
June 7	3	0	
8	6	2	
9	no collection		
10	8	11	
11	4	5	
12	no collection		
13	"	"	
14	2	5	
17	1	5	Also 1 male hyperparasite (Ichneumonid)
22	2	Hyperparasites	(Eurytoma)
25	2	"	(Ichneumonids)
29	1	1	Both hyperparasites(Ichneumonids)
Total Coeloides sp.	24	28	
" Eurytoma	2	0	
" Ichneumonids	4	1	

One can see from the above two tables that while the males begin to emerge earlier than the females, there is not as long a period of time separating their emergence (from cocoons kept under artificial conditions) as was found under field conditions. The artificial conditions may have accounted for this variation in emergence; nevertheless, it appears to be a fact that the majority of males emerge previous to the females.

The data given below in Table III are entirely inadequate but they are recorded to show what at least is an indication of the insect development causing the earlier emergence of the males.

Table III

Coeloides sp.

Larvae Collected May, 1929, from Cocoons Spun June, 1928.

Larvae pupated between	Pupae transformed between	Sex	Stadium in Days Maximum
May 17 and 18	May 26 and 28	Male	11
" 20 and 21	" 31 and June 1	Male	11
" 20 and 22	June 10 and 11	Female	22
" 26 and 28	" 3 and 5	Male	10
" 26 and 28	" 3 and 5	Male	10
" 26 and 28	" 5 and 6	Female	11
" 26 and 28	" 7 and 8	Male	13

Average maximum period - males 11 days.
Average maximum period - females 17 days.

It appears from the above table then that in brood of the main generation the males emerge earlier than the females because they have a shorter pupal stadium, which would indicate that they have a higher metabolic rate than the females, rather than that the males having a lower mean heat requirement for their metabolism can pupate earlier than the females.

In the field all of the cocoons spun in June, 1928, were found empty by June 17, 1929. As the first adult was found May 21 it would seem that the period of emergence for Coeloides sp. occupies about four weeks.

During the first three weeks of emergence males were very numerous on trees containing the parasite cocoons; not infrequently as many as 12 or 15 male Coeloides sp. would be found in an area that could be covered by a silver dollar. Every instance like this investigated disclosed a female Coeloides sp. chewing her way out from the cocoon under the bark. Evidently there must be an extremely attractive penetrating odor emanating from her. The female is fertilized immediately after emergence by one of the waiting males.

After emerging the female flies to a tree attacked the previous August, now containing beetle larvae more than half grown, and then crawls over the bark surface "sounding" with her antennae for the larvae (very rarely eggs are laid on Dm pupae) beneath, which are detected, in all likelihood, by the vibrations caused by the mandibles scraping against the tree tissues when feeding. The parasite does not employ entrance, air, nor exit holes, as a means of getting closer to the larvae or finding better going for her ovipositor, nor, in fact, does the adult Coeloides sp. ever see the beetle larva on which her egg is laid; nor would she, as experimentation has proved, lay her eggs on an exposed larva however long the two remain together.

When a suitable host is found (no matter how it is accomplished) the parasite raises the end of her abdomen until the ovipositor is in a vertical position. She then adjusts herself until the tip of the terebra is over the selected larva, sometimes taking several minutes before she appears satisfied with her position, at other times but a second. Next a slight vertical vibration of the abdomen occurs as the ovipositor is worked into the bark. When the female reaches the host she depresses the terebra suddenly, forcing it, perhaps, through the cuticula of the larva. If this is what happens, it is not, however, to lay the egg, since the egg is deposited on the surface of the larva, frequently even upon the head capsule, though the precise time that the egg is deposited could not be determined. The length of time required to penetrate the bark probably varies with its thickness, texture, and moisture content; 12 minutes was the shortest time observed, and 50 minutes the longest. Immediately after the sudden depression of the terebra, mentioned above, the female withdraws it, usually wipes it off with her hind legs, and goes in search of another victim.

The victims selected appear to be the larger larvae, and there are strong indications that the parasite concentrates on the last or the last two instars. However, data at present are insufficient to warrant a positive statement in regard to this point. A parasitized beetle larva, usually within two days after the egg has been laid, becomes inactive (though they show the effect after four or five hours), i.e., when stimulated by some object such as forceps, it either shows no signs of life or moves only slightly and ceases movement much sooner than a nonparasitized larva that has been stimulated. In other respects, except for a very

slight darkening of the tissues, the parasitized larva does not differ from a nonparasitized one until a great deal of the larval fluid has been sucked out by the parasite, causing the cuticula to collapse. Whether the mummified condition is caused by the parasite piercing the larva and injecting a paralyzing fluid, or whether it is due to the mechanical effect of the puncture alone, has not been determined conclusively. Experimentation has demonstrated that piercing the cuticle of a beetle larva with a fine needle tends to produce the same effect as piercing with a Coeloides ovipositor; but the larva pierced by a needle frequently blackens, and in many cases shrivels, after a few days. On the whole the needle-pierced larvae do not remain in a state of preservation as well as the Coeloides-pierced larvae. In performing the puncturing operation it is necessary to shorten the Coeloides ovipositor, as the natural length terebra is too flexible to enable one to pierce the cuticula of the beetle larva with ease. That portion of the ovipositor remaining attached to the body is the part used in the operation, and on the tip of it there appears a globule of colorless liquid, but whether this fluid is the element that causes this better state of preservation among the Coeloides-pierced larvae has not yet been determined. Nevertheless, it is strongly believed that such is the case, since it is known that certain other hymenopterous insects (2) embalm the prey on which they lay their eggs.

Adult Coeloides sp. collected in the field have been kept alive in captivity from 16 to 32 days, but the average number of eggs laid by an individual each day has not been determined. Therefore, we have no idea of their fecundity, though an estimate of 25 is hazarded.

Egg

The uniformly whitish eggs (Plate 4, Fig. 1b) average 1.2 mm. in length and about 0.3 mm. in diameter at the middle. They are somewhat larger at one end than the other, frequently with a slight curve at the smaller end; the surface is smooth and somewhat shining. From two to four days is required for them to hatch. Table IV below gives the data secured concerning the time laid, the length of the eggs, and periods required for hatching.

(2) The Psammocharidae. Imms. p. 573.

Table IV

Data on Eggs Laid by Coeloides sp.

(Brackets enclose eggs laid by same individual)

Time Laid		Length in mm.	Hatched between	Max. time elapsed between time egg laid and larva hatched
	June			
(Between 7.45 p.m. and 6 p.m.	3			
)	4	1.37	Did not hatch	
(do		1.40	do	
) "		1.37	"	
(Between 5 p.m. and 5 p.m.	5	1.24	8 a.m. June 7 and 8	2 days
)	6	1.32		
(do		1.32	do	do
(Between 5 p.m. and 5 p.m.	5			
)	6	0.96	Hatched by June 10	4 days
*(Between 11 a.m. and 9 a.m.	8			
)	8	0.90	Did not hatch	
	August			
(Between 8 a.m. and 6 p.m.	3			
)			8 a.m. and 10.55 p.m. Aug.6	86 hours
(do			do	do
) "			"	"
(Between 10 a.m. and 10 p.m.	6		9.20 p.m. Aug. 7 and 8.20 a.m. Aug. 8	46½ hours
(Between 10 a.m. and 10 p.m.	6		8.30 a.m. and 8.20 p.m. Aug. 9	26½ "
Between 5 and 5.30 pm	13		Aug. 15 and 11.55 pm Aug.16	65 hours
Between 5.45 and 6 pm	13		do	65 hours
4.35 p.m.	20	1.08	1.50 p.m. Aug. 24 Just emerging.	
4.55 p.m.	20	1.08	Did not hatch	
August 22		1.32	do	
3.45 p.m.	20		2.45 Aug. 24 Just emerging	95 hours

* Laid through lodgepole bark by female reared from cocoons collected in white pine, Troy, Montana; female fertilized by male reared from cocoons collected in lodgepole, Sula, Montana.

Records of eggs laid in the field and left in the tree under natural conditions were difficult to obtain, due to the fact that the bark had to be removed from over the larva on which the adult parasite was seen to work, in order to determine whether or not the egg was laid and upon which larva. Frequently examination revealed no eggs. In that case the larvae in the adjacent area were collected to find out whether or not they would become mummified, but none ever did. Thus it seems likely that the adult may miss the larva with her ovipositor and not lay an egg; in any case it appears at times that no egg is laid, though the female may spend an half hour penetrating the bark. If an egg has been laid the bark square removed is replaced and held in position with a stout pin. However, when the square is next examined, staphylinids, Lasconotus, Epuraea, and Laemophloeus are usually found under it, and as all but the latter species are known to be predacious, if the beetle larva and parasite egg are still present, they will not be for long, for whichever species it is that removes them soon does a good job. Nevertheless, two records were secured in the field: one showed an egg period of 93 hours; the other 95 hours.

Larva

The larva (Plate 4, Fig. 1c) is approximately the same size and color as the egg from which it emerges, and the head, though the same color as the rest of the body, is easily distinguishable in this stage. However, as the larva grows in size the head becomes more retracted within the thorax. (Plate 4, Fig. 1). The young parasite, though apodous, crawls about over the surface of the beetle larva, which by this time is thoroughly "mummified", until it finds a suitable spot to feed. The parasite larva is found on any part of the beetle larva, except the head capsule through which it does not feed, occurring on the dorsal, ventral, and pleural regions, cephalad as well as caudad. The Coeloides sp. larva has but vestigal mouth parts, of which the best developed are the mandibles (Plate 4, Fig. 1a), and with which it apparently punctures the cuticle, sucking up the fluid that exudes therefrom. As soon as feeding begins the growth is rapid, especially in width; consequently, instead of being elongate with nearly parallel sides, it appears, after 8 to 10 days, more or less, swelled (Plate 4, Figs. 1 and 1c), with the segmentation less distinct. As the parasite larva matures small whitish "fat-bodies" develop beneath the cuticle. The earliest recorded appearance of these is three days after hatching, but this is unusually early. It is believed that the bodies are excretory in function as no exuviae were found for any of the larvae reared. When the larva is nearly mature the lipoid bodies, as the "fat-bodies" are tentatively called, assume a slight yellowish cast, as does the rest of the larva. Usually when this becomes marked the parasite larva, within a few days, ceases feeding. It may spin a cocoon immediately, as is usually the case; or delay, for some as yet unknown cause, an indefinite period. The shortest recorded elapsed time from the time the egg was laid until a cocoon was spun is 15 days, but larvae under nearly identical conditions have been found which do not spin cocoons after 80 days, though no feeding had been done for the preceding 55 or 60 days.

By the first week in July a great majority of parasite larvae have spun cocoons (Plate 4, Fig. 1d). These, which are 4-5 mm. in length, may be divided into two groups: (1) those that are nearly white; and (2) those that are rather tan, but the two colors appear to have no significance. Cocoons of both colors are found side by side; males and females emerge from either, and both types contain overwintering larvae.

The cocoons of the early generation are generally smaller than those of the main generation, probably because the larvae parasitized in the fall are considerably smaller than those parasitized in the spring, and thus the parasite larvae having less to feed upon are proportionately smaller.

Pupa

Pupation under normal conditions always occurs within a cocoon spun by the larva. If a cocoon containing a pupa is cut open the female Coeloides sp. can easily be distinguished from the male by the presence of the ovipositor which is curved up over the abdomen.

The pupal stadium and emergence has of necessity been discussed on page 5. During early May, 1929, pupae were found in cocoons in Du 28 trees, but most of them were blackish looking and it appeared as though they had been injured by cold weather. They pupated, under all probability, the previous fall; none that were collected transformed.

The above is the general life history of the main generation of Coeloides sp. There is, however, still another emergence (cf. Chart I), the cause of which has not been determined. While probably about 95 per cent of the brood of the main generation overwinters the remaining per cent pupate very soon after spinning their cocoons; transform in about 10 days, and emerge during the latter part of July. An examination in the field, June 7, 1929, of 139 Coeloides sp. cocoons (spun June, 1928) selected at random, showed five empty cocoons from which emergence had occurred the previous season. This would mean an emergence of 3.6 per cent. However, Tables V and VI below would indicate a different per cent emergence.

Table V

Summer Emergence* from 61 Coeloides sp.
Cocoons Spun June, 1929 - Collected July 8, 1929

Emergence 1929	Male	Female
July 18 (first emergence)	2	1
19	2	1
20	0	2
21	1	0
22	1	1
23	1	0
24	0	0
25-31	0	1
Aug. 1-2	0	0
3	0	0
4-31	0	0
Sept. 1-30	0	0
Oct. 1-31	0	0
Nov. 1-30	0	0
Total	7	6

Per cent total emergence 21.4.
*Kept in glass vial entire period.

Table VI

Summer Emergence* from 500 Coeloides sp.
Cocoons Spun June, 1929 - Collected July 18, 1929.

1929	Male	Female
July 18	0	0
19	1	0
20	0	2
21	0	1
22	0	2
23	0	9
24	0	3
25	0	0
26	0	0
27	0	0
28	0	1
29	0	1
30	0	0
31	0	0
Aug. 1-31	0	0
Sept. 1-30	0	0
Oct. 1-31	0	0
Totals	1	19

Per cent total emergence 4.0.
*Kept in Plaster of Paris container entire period. Container moistened frequently every week until August 25.

Table V shows a 21 per cent emergence; Table VI but a 4 per cent emergence. Averaging the per cent for the two tables we arrive at a 5.9 per cent summer emergence for the 1929 season as against the 3.6 per cent summer emergence of previous season.

Since the figures for the past season were secured from cocoons kept under artificial conditions this may account for the great discrepancy in the data in Tables V and VI. Whether the factors, causing the greater emergence and the equal numbers of both sexes for those reared in the glass vial as against those causing the lesser proportional emergence and preponderance of females, are due to the inherent biological character of Coeloides sp., a distinct race, or artificial conditions alone, is difficult to say.

The larvae, cocoons, and adults of the summer emergence are indistinguishable from those of the main overwintering generation. The cocoons of the former are not found in localized groups, nor are they confined to the warmer sides of infested trees.

That there are adult Coeloides sp. present in August and September is accounted for not only, perhaps, by the length of life of those emerging in May, June, and from the above-mentioned summer generation, but also by the fact that the imago does not confine its attack to the larvae of Dm. It parasitizes as well sundry species of Ips, chiefly oregoni Hopk., probably because the larvae are in greater abundance than the other species. Since Ips oregoni has several generations a year, the adult parasites have sufficient material to work upon after the Dm brood has completed its larval development. Consequently Coeloides sp. are probably parasitizing Ips oregoni the entire season, and it therefore follows that a few will most likely be emerging over a range of several months that season as well as the spring of the following season.

Coeloides sp. larvae have not, to date at least, been collected from Hylorgops larvae, nor was it possible to get the adult to parasitize them in the field laboratory. The same applies to Cerambycid larvae.

Economic Status

There is no doubt that the most important parasite of the larval stage of Dm in lodgepole pine in the region of Sula, Montana, is Coeloides sp. The importance of Coeloides sp. seems to vary, however, with the length of time an infestation has been present on an area. Where Dm has been present for the shortest time, which is in the outlying groups, parasitism by Coeloides sp. has been found the lowest. This is probably

due to a number of factors. The Coeloides sp., found generally over the forest in Ips-infested windthrown, snow-broken, and otherwise damaged, trees, are probably insufficient in numbers the first year or two after Dm arrive to parasitize a large per cent of them. A second factor is related to the life history of the parasite. The main generation of Coeloides sp. remains in the killed trees nearly a year after their Dm host has left; see Chart I. By the time the parasite emerges at least the van of the main body of the infestation has left them behind and it is not unlikely that instead of "catching up" with the Dm in the outlying groups they will concentrate chiefly on the insects nearby. Such action would prevent heavy parasitism of Dm in the outlying groups until these groups have become practically a part of the main body of the epidemic. It is thought that a combination of these two factors (1) small numbers of parasites present when Dm enters an area; and (2) slowness of the parasite in "catching up" with its host are partly responsible for the low parasitism in the outlying groups.

Inability to multiply rapidly is thought to be another factor tending to the slow increase in parasitism in any area. The female Coeloides sp. probably lays not over 25 eggs. Laying, as she does, but one egg on each beetle larva the female parasite must expend a great deal of time and energy for each egg laid. Added to this handicap is the fact that the parasite has but one main generation per year.

These limiting factors seem to have resulted in the failure of the parasite to become more important as a controlling factor.

The value of these observations on parasitism lies in indicating that where only partial control is possible it should be concentrated on the part of the epidemic that has been established the shortest time. It has also been found that Coeloides sp. does not begin to be very effective until June. If control work could be confined to the fall of the year it is felt that an increase in per cent of parasitism would be gained. Control in the fall would kill all the Dm and leave practically all the emerging Coeloides sp. to work on a reduced brood of Dm.

Where only partial control is possible, by confining control work to the more recently established part of an infestation and to the fall of the year, we should be able to favor the increase of this important parasite. If control of the entire epidemic is possible confining the control work to the fall would probably make this parasite much more effective in controlling the brood in the trees inevitably missed in any large control operation.

Tables XXII and XXIII at the end of the report show the data concerning the factors just discussed.

Other Hosts

Western white and white-barked pines infested with Dm (has not yet been found on Dm in yellow pine) Ips oregoni, emarginatus, vancouveri?, Pityogenes (rarely) and Orthotomicus.

DENDROSOTER SP.

(Hymenoptera Braconidae)

This is a rather common species of parasite first found on the bark of Dm infested trees in late May, the season following the beetle attack. Mixed up with the work of Dm one finds, very frequently, the galleries of Ips latidens and it is apparently the larvae of this species, and not the larvae of Dm for which the females are searching. Of the many hundred cocoons collected from Dm galleries, only one or two Dendrosoter sp. adults have been reared -- and the cocoons of these may have been included by an oversight, since Dendrosoter is the common parasite reared from cocoons collected in Ips latidens galleries. However, in the laboratory this species laid eggs freely on larvae of Dm so that under natural conditions a few mountain pine beetle larvae may be parasitized.

Adult

The average length, including the ovipositor, of the female (Plate 4, Fig. 7) is about 4.8 mm.; max. 5.5 mm.; minimum 2.5 mm.; color of head, thorax, and abdomen, dull, nearly black, the head occasionally with a lighter reddish area above and around the eyes. Legs brownish, all joints the same color except the coxae which approach the color of the thorax. The adults resemble a small Coeloides, but each forewing bears two dark areas (cf. wing in Fig. 7, Plate 4) and the abdomen is always dark, never red.

The first adult of the 1929 season was observed May 21 on the bark of a Dm tree, and after a few days both sexes, which were in equal numbers, were not uncommon. Oviposition habits are like those of a Coeloides sp. and a single egg is laid on a beetle larva.

An adult collected May 23, 1929, laid an egg on a Dm larvae in the laboratory that same day; others collected at the same time laid eggs the following day, and a few continued to oviposit until June 1.

The reaction of the beetle larvae to the oviposition of Dendrosoter is the same as that of Coeloides sp., i.e., the larvae become "mummified" within a short time after the act.

Egg

The egg (Plate 4, Fig. 7b) is slightly smaller than an egg of Coeloides sp. and does not taper as abruptly at one end. It is a translucent white in color; average length .69 mm., and hatches 7 to 10 days after being laid. Table VII below summarizes the data obtained concerning the length of the eggs, the egg period, the size of the emerged larvae, and the lengths of the larvae after feeding 2, 5, 10, 15, and 20 days.

Table VII

1929 Date Laid Between	Length in mm.	Date Hatched Between	Max. Period (Days)	Length in mm. of larvae hatching	Length in mm. of larvae after feeding 2	5	10	15	20 Days
V-23; 11.30am and 24; 8.30am	.689	VI-1 and 2 2 P.M.	10	.325		1.02		2.25	2.88
V-24; 11 am and 25; 9 am	.650	VI-2; 2 pm. and 3; 3 pm.	10	.424					
do	.750	VI-1 and 2 2 pm.	9	.50					
"	.675	VI-1 and 2 (missing)	9 ?	--					
V-24; 11 pm. and 25; 9 pm.	.725	VI-1 and 2 2 p.m.	9	.20			.636	2.16	
V-25; 11 am. and 27; 9 am.	.675	VI-2 and 3 3 p.m.	9	.477		.795			
do	.720	VI-3; 3 pm. and 4; 545 pm.	10	.424		.636			
"	.729	VI-2; 2 pm. and 3; 3 pm.	9	.45					
"	.63	"	9	.424			.954	2.2	2.88
V-27; 9 am. and 28; 11 am.	.72	VI-2 and 3	7	.477					
V-30; 12 M. and 31; 11 am.	.76	VI-6; 5 pm. and 8; 8 am.	9	.45					
V-31 and VI-1; 2 pm.	.742	"	8	.42	.53	.65			3.6
"	.689	Did not hatch	--	--					
"	.689	VI-6; 5 pm. and 8; 8 am.	8	.40	.63		1.71		
"	.589	"	8	.42					
"	.69	Did not hatch	--	--					
	.695 average			.414 average					
	.75 max.; min. .589			.50 max.; min. .20					

Larva

With the exception of the larvae of Dendrosoter all of the emerging larvae studied so far were the size of the egg from which they hatched or larger; those of Dendrosoter were but two-thirds the length of the egg at time of hatching.

The larvae resemble those of Coeloides sp. so closely as to be inseparable; the head capsule as well as the rest of the body being similar.

Growth is rather rapid as can be seen by the foregoing table. The mature larvae are 4 to 5 mm. in length, though some spin cocoons when smaller. One definitely known feeding period occupied 24 days, from June 2 when it hatched from the egg to June 26 when it was observed spinning a cocoon.

Pupa

Pupation undoubtedly occurs within the cocoon. The length of six pupae averaged 4.6 mm. These were secured from cocoons in Ips latidens galleries, August 26, 1929, and of four saved for rearing, three emerged by September 8, 1929; the other died. At least one and a half generations a year are indicated with an emergence in September and the occurrence of adults in late May.

Type full page

THE CHALCIDS

The characters summarized below are common to the chalcids found associated with the mountain pine beetle in lodgepole pine. A detailed description of each species follows this summary.

Adults

Antennae-elbowed (Plate 4, Figs. 2e, 3d, 4d and e, 6a, and the antenna in Fig. 5c).

Wings; veination reduced to that as shown in Figs. 2d, 3c, 4d, 5c, and 6, Plate 4. There are never any closed cells.

Lengths - None over 7 mm.; rarely under 3 mm.

Larvae

Habits - Feed externally on surface of host, never spin cocoons.

Body - Thirteen segments besides head. Mature and nearly mature larvae of shapes shown in Figs. 2, 3, 4, and 5, Plate 4; no "fat-bodies" visible beneath cuticula.

Head capsule - Without any distinct characters save the mandibles of Eurytoma which are easily discernible. Compare Figs. 2a, 3a, 4a, and 5a, with Fig. 1a.

Vesititure - No hairs whatever visible without aid of high-power microscope except Eurytoma where they are distinctly apparent.

Spiracles - Nine pairs, a pair each on the meso- and meta-thoracic and the first seven abdominal segments.

Color - Creamy white to chalk grey, shiny, surface never dull, shagreened, or markedly striated.

Lengths - Mature larvae between 3 and 6.5 mm.

Pupae

Type - See Plate 4, Figs. 2b, 3b, 4c, and 5b. Ovipositor of female never turned up over abdomen as Coeloides sp.

Color - Creamy white until a few days before emergence when they begin to turn brown and turn continually darker until one can detect the color of the adult insect through the pupal skin.

Lengths - 3 to 6.5 mm.

EURYTOMA PISSODIS Gir.

(Hymenoptera-Eurytomidae)
External Secondary Parasite

This species is a fairly common secondary parasite on the larvae of Coeloides sp. on which it lays its eggs, both before and after they have spun their cocoons. The hyperparasite has never been found ovipositing on Dm larvae but this it may do rarely; in one very peculiar instance a Eurytoma was observed boring over and apparently ovipositing on, what proved to be, when the bark was removed, a newly transformed Dm adult. The complete seasonal history has not been worked out but most of the eggs are laid in late June and in July. A few of the larvae transform and emerge the same season; the rest do not pupate until the following spring.

From 179 Coeloides sp. cocoons collected in May, 1929, from Dm 27 trees, 7 Eurytoma were reared, a 3.9 per cent parasitism of the Coeloides sp. within cocoons.

Adult

The females (Plate 4, Fig. 4d) vary in length from 3.5 to 6 mm.; the body is pitch black with the head and thorax strongly sculptured, dull in finish; eyes black; the abdomen, compressed laterally, is smooth and shining; the scapes of the antennae (Plate 4, Fig. 4e) vary in color from black to reddish, the remaining segments are black; the basal joint of the legs are always black, the other joints vary in color from occasionally yellowish to reddish-black and black.

The male is smaller than the female, averaging between 2 and 3.5 mm. It differs also by having knotty antennae (Plate 4, Fig. 4f); a globose rather than flattened abdomen (Plate 4, Fig. 4g), and the legs, which except for the coxae are generally light reddish-yellow.

Though the adults are found on the bark of Dm infested trees the same season as the attack, probably in search of the few Coeloides sp. in the tree, the greatest numbers are seen during the latter part of June and early July, the season following the beetle attack. The first adult found in the field was a male on June 19, 1929; by June 27 both sexes were common. It is not known whether the males generally emerge prior to the females.

The habit of oviposition is similar to that of Coeloides sp., but Eurytoma pissodis not infrequently utilizes oviposition holes of other parasites. The female has been commonly observed standing behind an ovipositing Coeloides sp. waiting until she finishes her operation, which is no sooner completed than it dashes in and oviposits through the hole just made.

Egg

The egg (Plate 4, Fig. 4b) is black in color due to the spines, oval in shape, and averages about .6 mm. in length and .27 mm. in width. The surface is entirely covered with stout spines, and at either end of the egg two larger and longer spines project.

Table VIII below gives the data on the eggs observed.

Table VIII

1929 Egg Laid	1929 Egg Hatched Between	Maximum Period	Length of Hatched Larva
VII-10; 1.40 pm.	VII-15, between 9 am. and 4.35 pm.	5 days	.636 mm.
VII-10; 1.40 pm.	VII-15, larva half out of shell, 4.35 pm.	5 days	----
VII-15; 2.35 pm.	VII-18, could not find egg.	--	--
VII-15; 11.59 a.m.	VII-17 and 18	3 days	.56 mm.

The eggs are laid on the surface of Coeloides larvae either before or after the cocoons are spun; generally a single egg is laid but in one instance two eggs were deposited within a Coeloides cocoon, and many times adults have been observed to apparently oviposit six or seven times in the same hole, though no eggs have been found beneath when the bark was removed.

Larva

The head of the first instar larva has a slightly yellowish cast and is more prominent than when the body grows larger. The rest of the body is creamy white in color. The head capsules of the later stages lack the pronounced yellowish cast of the first instar, but all stages agree in having, through to pupation, prominent bifid mandibles, and long, slender hairs visible to the unaided eye on all the body segments (Plate 4, Figs. 4 and 4a). These characters are not present on any other chalcid larvae.

Some of the larvae on hatching crawl from the egg shell to feed; others remain within their eggshell for a few days, and feed on their host with only the head projecting. The mature larvae vary from 4 to 5 mm. in length. The larvae are frequently observed in Dm larval mines, but one could not tell

whether they had been feeding on Dm larvae primarily, or secondarily on the primary Coeloides sp. larvae, as the head capsules of the beetle larvae always remain, but those of the Coeloides sp. larvae are not sufficiently hardened to persist. Eurytoma larvae have been collected feeding on Coeloides sp. larvae but none as yet, as far as is known, have been found feeding on Dm larvae.

The larval stage varies from two months to nearly a year, a few pupate the same season they hatch, but most of them pupate the following spring. Pupation occurs under the bark in the larval gallery or pupal pit of Dm or within the Coeloides sp. cocoon, depending upon the circumstances under which the Eurytoma eggs were laid. In the two former cases the cambium surface around the larva often becomes coated with a whitish powdery substance resembling a mildew but which apparently in no way affects its well-being.

Examinations of Coeloides sp. cocoons the past season (1929) never revealed more than one Eurytoma larva within a cocoon, but as it is known they may lay at least two eggs within one cocoon it seems likely when more than one is present that after the Coeloides sp. larva is consumed one of the Eurytoma larvae devours the other.

Pupa

The pupae (Plate 4, Fig. 4c) average in length 4.5 mm.; the antennae extend practically halfway to the end of the wing and by this character can be distinguished from other chalcid pupae of similar size.

Table IX below gives the data secured concerning the pupal stadia.

Table IX

Year of Beetle Attack of Tree in which Larva or Pupa was Collected	1929 Date on which Changed to Pupa - between	1929 Date transformed, between	Stadium Max. Period (Days)
1927	May 17 and 21	June 11 and 12	30
1927	June 27 coll. as pupa.	June 28 and 30	3
1928	July 13 and 15	July 25 and 26	13
1928	July 17 coll. as pupa.	July 27 and 28 (out about 8 hrs.)	11
1928	July 26 and 27	Aug. 6 and 14	11-18
1928	Aug. 1 and 2	Aug. 6 and 14	5-13
?	Aug. 3 and 5	Aug. 17 and 18	15
?	Aug. 6 and 14	Aug. 15 and 16	2-10
1928	Sept. 12 and 27	By Oct. 16	--

Of the three periods known with any degree of certainty one is 13, one 15, and the last one 30 days, the longest period being the pupal stadium of an overwintering larva, the others from larvae pupating in one season.

Economic Status

Of 179 Coeloides sp. cocoons, spun in 1928, from which emergence occurred during the spring of 1929, 172 were Coeloides sp. and 7 Eurytoma, a 3.9 per cent parasitism of the Coeloides sp. cocoons collected. But some Eurytoma emerge from the cocoons the same season they are spun, still others feed on Coeloides sp. larvae before they spin cocoons; as in neither case is the per cent known, the figure of 3.9 per cent parasitism does not tell the whole story. While no worth while figures were secured regarding the first two mentioned points, from general observations the impression is that together these would equal the 3.9 per cent parasitism shown by spring emergence from the Coeloides sp. cocoons. Thus, we may estimate a total of about 8 per cent parasitism of the Coeloides sp. larvae for the past year. If this per cent does not increase Eurytoma can not be considered of great importance in the reduction of Coeloides sp. brood.

CECIDOSTIBA DENDROCTONI Ash.

(Hymenoptera - Pteromalidae)
External Parasite

Next to Coeloides sp. this species is the most common hymenopterous parasite of the larvae of the mountain pine beetle in lodgepole pine, but it is not found in sufficient numbers, however, to be of itself important as a controlling agent. There are probably two generations a year, one on Dm, the other on Ips larvae or allied species.

Adult

Female (Plate 4, Fig. 5c), average length 6 mm.; head and thorax greenish with surface strongly sculptured; eyes black; abdomen black; antennae blackish except basal joint which is usually straw colored; coxae blackish, front surface only, green; trochanters, tibiae, and tarsi straw colored; femora greenish-black except at extremities which are color of tibiae.

Male somewhat smaller than female, but in general shape closely resembles it. It differs from the female chiefly in that in color the base of the abdomen is yellowish, and in shape not flattened laterally; and the legs seem to be generally darker.

The adult oviposits through the bark in the manner of Coeloides sp. and probably lays but a single egg. The eggs are laid on the beetle larvae or rarely on a pupa. The main period of oviposition is during June shortly after its emergence.

Egg

Not known.

Larva

The mature larvae (Plate 4, Fig. 5) average in length 6 mm.; the body is uniformly whitish to grey, no hairs whatever are visible to the unaided eye. Under a microscope the head (Plate 4, Fig. 5a) can be seen to bear several small spines. The mandibles are simple and indistinct.

The period of feeding is not known but as far as can be judged none of the larvae feeding on Dm larvae overwinter; instead they transform and emerge in time to work on other hosts.

Pupation occurs under the bark in no especially constructed cell.

Pupa

The pupae (Plate 4, Fig. 5b) average in length 4.5 - 6 mm. The antennae vary in length from slightly less to slightly more than the length of the wing (cf. Fig. 5b), but always extend beyond the extremities of the first pair of legs. In all the other chalcid pupae found in Dm infested lodgepole the antennae do not extend to beyond three-fourths the length of the wing, and are shorter than the first pair of legs.

Table X below gives the data obtained concerning the pupal stadia.

Table X

Collected as	1929 Date of Collection or Period in which Changed to Pupa	1929 Date or Period in which Emerged	Stadium Maximum Period (Days)
Pupa	May 9	May 29	20
Larva	May 16 and 17	June 3 and 5	20
Larva	June 1 and 3	June 15 and 17	16
Pupa	July 16	July 28	12
Pupa	July 17	July 24 and 25	8
Larva	July 19 and 20	July 30 and Aug. 2	14
Pupa	July 20	July 30 and Aug. 2	13
Pupa	July 20	July 30 and Aug. 2	13
Pupa	July 20	July 30 and Aug. 2	13
Larva	July 25 and 26	Aug. 4 and 5	11
Pupa	Aug. 2	Aug. 2	0

Economic Status

Counts made between June 4 and July 26, 1929, of 113 square feet of bark surface from 23 Dm 25 trees showed an average of .18 pteromalids per square foot. Since in the field one can not differentiate between the pteromalid genera this count also includes Rhopalicus and Pachyceras larvae. Thus it is seen that if the number of larvae of this family taken as a whole averages but .18 per square foot, the occurrence of one of its parts is still less. Consequently neither this genus nor either of the other two genera mentioned subsequently can be considered to be of any appreciable value as controlling agents of the Dm brood.

It appears that the pupal stadium is about a week longer in the early part of the season than later when the weather is warmer. How long the pupae collected in the field had been in that stage could not be said but the fact that none of them exceeded the stadia of those reared from the larval stages shows that during mid-season the period is not likely to be over two weeks.

RHOPALICUS PULCHRIPENNIS Cwfd.

(Hymenoptera-Pteromalidae)
External Parasite

Rhopalicus pulchripennis is a rather common and beautiful blue-green species of chalcid found on the bark of Dm infested trees. It is, however, a more important parasite of Ips than Dm larvae. They may also at times be a secondary parasite on Coeloides as one was found dead May 4, 1929, in the bottom of a rearing jar in which only Coeloides sp. cocoons from a Dm 27 tree were present, and on another occasion one was observed to oviposit in an oviposition hole made by a Coeloides sp.

Adult

The females (Plate 4, Fig. 2d) average about 4 mm. in length. The head and thorax are a dark green, the surface strongly sculptured, eyes red, the abdomen greenish black, smooth, and shining; antennae blackish, except for scape which is usually straw colored; legs straw colored, the hind legs somewhat darker than the others; forewing crossed near center with distinct dusky band about one-fifth to one-sixth as wide as the length of the wing. (Cf. Plate 4, Fig. 2d).

The males are similar to the females in general appearance though somewhat smaller in size.

The adults are first seen the latter part of May, but after that can be found all season long. While they lay eggs on Dm larvae, both the season of the attack and the following May and June they more commonly parasitize Ips and perhaps Pityogenes and Orthotomicus.

Oviposition is through the bark and in the same manner as Coeloides sp.

Egg

But a single egg was secured for this species. Its characters were as follows: (length .495 mm.; width .18 mm.; color creamy white, surface slightly shining, with no distinct markings; shape oval (Plate 4, Fig. 2c).) The egg did not hatch.

Larva

The larvae (Plate 4, Fig. 2) superficially resemble the other chalcid larvae. The average mature larva is about 3.5 mm. in length, is greyish white in color and the surface is distinctly shining; no hairs are visible to the unaided eye. The head is fairly prominent; the mandibles simple, indistinct. If the larva is placed under a high-power microscope a single hair is visible on the dorsum of each segment except the head which has four and the terminal segment which bears three or four hairs.

While the general period of feeding is not known it is at times 15 days or more. After feeding has ceased the larva may pupate and transform immediately; remain as a larva several months and then pupate and emerge the same season, or overwinter as a larva and pupate in the spring.

Pupa

The pupae (Plate 4, Fig. 2b) vary from occasionally 3 mm. to 4.5 mm. in length. The antennae do not extend to or beyond the extremities of the first pair of legs; the third pair of legs extend more than half the distance between the caudal extremities of the wing and the apex of the abdomen.

Pupation occurs under the bark in no specially constructed cell.

Table XI below gives the data obtained concerning the pupal stadium.

Table XI

1929 Collected as	1929 Date of Collection or Period in which Changed to Pupa	1929 Date Emerged	Stadium Maximum Period (Days)
Larva , May 9	May 16 and 18	May 31 and June 1	15
Larva May 8	May 18	June 3 and 5	18
Pupa	May 24	June 5 and 6	13
Pupa , June 4	May 30 and 31	June 10 and 11	11
Larva, June 4	June 18 and 21	June 25 and 26	8
Pupa	July 16	July 20 and 21	4
Larva, July 22	July 25 and 26	Aug. 5 and 14	12-20
Larva, July 25	July 27 and 28	Aug. 5 and 14 Oct. 5, 1928	10-18
Pupa	Aug. 15, 1928	Sept. 20 and Oct. 5, 1928	26-41
Larva, Aug. 26	Sept. 12	Sept. 27 adult dead when collected.	15 (?)

While the data above are not very conclusive they show at least that pupation occurs practically all summer long and individual cases show in one instance 8 days was the shortest and 26 days (at least) the longest definitely known pupal periods.

Economic Status

The importance of this species as a controlling agent of Dm in lodgepole is negligible. See discussion under "economic status" of Cecidostiba, page 23.

PACHYCERAS ECCOPTOGASTERI Rats.

(Hymenoptera-Pteromalidae)
External (?) Parasite

This is a less abundant species of chalcid which, unlike the others occurring on Dm infested trees, has never been found ovipositing through the bark, but instead enters Dm ventilation holes in order to oviposit. Because of this habit its manner of laying eggs and its host is not known definitely. Several times, however, while peeling the bark from infested trees, adults have been found with their ovipositor stuck in the cambium on one side of the egg gallery. Upon what they had been working was not determinable though it is believed that they are larval rather than egg parasites of Dm. The parasite larvae are found in the Dm larval mines but none as far as is known have been collected feeding on the beetle larvae. Their status, therefore, of whether they are primarily or secondarily parasitic, is not known.

Besides this species there is a smaller one closely resembling it except in size. Nothing is known of its seasonal history or habits.

Adult

The adult females (Plate 4, Fig. 3c) average 3.5 to 6 mm. in length, including the ovipositor. The head and thorax are dark green, with a bronzy tinge; the surface lightly sculptured; eyes black; the abdomen is bronzy black, smooth, shining; the joints of the antennae are dark, except the scape which is often lighter in color, and becomes succeedingly larger towards the distal end (Plate 4, Fig. 3d); the basal joints of the legs are generally shiny blue, the other joints straw colored except the femora which are dark brown.

The male of this species has not been definitely determined.

The first adult was observed the past season on June 24 and after that time could be found the rest of the season on bark of Dm and other barkbeetle infested trees.

As mentioned above the female enters aeration holes and crawls up the galleries to oviposit. They have been observed to enter the galleries and remain under the bark as long as four minutes; at times when the bark has been quickly removed they have been found 4 and 5 inches from the opening through which they entered.

Egg

Not known.

Larva

Only a few larvae (Plate 4, Fig. 3) which belong to this species have been secured. These closely resemble the larvae of Cecidostiba in general appearance save being somewhat smaller, and by the lack of microscopic hairs on the head, but this latter character may be but an instar difference.

Pupation occurs under the bark in no specially constructed cell.

Pupa

The pupa (Plate 4, Fig. 3b) is, like the other chalcid pupae, a creamy white until just before pupation when they turn brownish. The characters which distinguish them from the other chalcid pupae are as follows: Average length 3 mm.; antennae do not extend beyond extremities of first pair of legs; and third pair of legs extend less than half the distance between the caudal extremities of the wings and the apex of the abdomen.

But two of this species were reared and only one of them from the larval stage. The data concerning them are given below.

Stage Collected	Date 1929	1929 Pupated between	Emerged between	Maximum Period
Pupa	June 26	--	July 8 and 9	13 days
Larva	July 25	July 30 and Aug. 2	Aug. 5 and 14	6-15 "

Economic Status

This species is of negligible value as a controlling agent of the mountain pine beetle in lodgepole. See discussion under "Economic Status" of Cecidostiba, page 23.

MEDETERUS ALDRICHI Wheeler

(Diptera - Predator-Dolichopodidae)

The importance of this species is difficult to estimate due not only to the fact that its larvae are predacious, and thus probably feed on more than one Dm larva, but also to the fact that they will feed on nearly any larva they chance upon, including their own. It is believed, however, that they are the first insect of any kind to follow Dm after it attacks a new tree. Since, save for their own species, the beetle larvae are the sole inhabitants of the tree, the predators get in their destructive work early, at a time when the Dm larvae are small and more than one must be preyed upon to furnish sufficient food for development. It may be mentioned here that this condition obtains for but a short period, as Lonchaea viridana Meigen larvae are found almost as early as Medeterus larvae.

There is probably more than one generation of Medeterus aldrichi a year, but an overlapping and inter-grading make it difficult to determine this. Eggs are apparently laid as long as there is brood of any kind within the tree; larvae are found all season long, while pupation and emergence too occur during most of the season. Table XII, page 32 shows the period over which pupae were found and some data concerning emergence.

Adult

The imago is a sombre grey and averages about 4 mm. in length. By the time the egg galleries of Dm are well advanced the females (Plate 2, Fig. 2G) have begun to oviposit. One was observed ovipositing July 29 on a lodgepole that had been attacked less than a week. Larvae have been collected from trees in which most of the beetle eggs were not yet hatched, or the larvae that were present had not, at most, completed the second instar. Small Medeterus larvae have been collected feeding upon Dm eggs.

The female fly's actions when searching for a suitable place to lay her eggs are very amusing. Instead of the ordinary fly walk, she appears to glide over the bark surface sidewise and backwards as easily and frequently as forwards, feeling with the tip of her abdomen for small openings, such as places where turning niches and air holes come out under the bark scales, or nearly come through at a crevice. If she, in her explorations, chances upon an entrance or exit hole, it is avoided by hopping away from it. The female apparently shuns such cavities as if "afraid" of falling in, none having ever been observed to enter, though another species of Medeterus seems to use these openings exclusively as a means of gaining access to the egg galleries.

Many Medeterus have been observed ovipositing upon trees under natural conditions, but subsequent examination of the spots has never disclosed any eggs, due probably to their small size, protective coloration, and the difficulty in getting the bark scales off evenly. Consequently the number of eggs laid at one time is not known. The act of oviposition usually occupies not longer than 20 to 30 seconds. It thus does not seem reasonable that the number laid at one time would be large; on the contrary one or two would seem the more credible. Still, under confinement, two groups of two eggs each and another scattered group of nine were found. The eggs in the former case were deposited under the edge of the bark square; in the latter case, on the bark surface; whereas in the field no eggs were ever found on the bark surface.

The adults may lay their eggs in the same tree from which they emerged, but whether the larvae that emerge from the eggs pupate and transform the same season, thus completing a second generation, or overwinter before pupating, is not known. Medeterus larvae have been collected from trees killed by the mountain pine beetle a year and even two years previously, but it is not believed that some of the flies have two-year life cycles so much as that their larvae, being predacious on many forms of subcortical larvae, occur wherever the adult finds conditions suitable. Larvae have been collected from trees containing mostly species of Ips, from tops of lodgepole pine in which insect larvae were present in the sour sap, and from yellow pine containing Dm brood. Adult Medeterus could be collected any time in Ips oregoni and Dm infested trees during August; in September some were collected the last day of the field season at Sula, Montana, September 17, and on September 23 at Wisdom, Montana. Thus it is seen that the species is not uncommon, and may be obtained in all forms, except perhaps the pupa, any time during the field season.

Egg

The eggs (Plate 3, Fig. 3) of a brownish-orange cast and shining, average .8 mm. in length and .18 mm. in width; they hatch 10 days to two weeks after being laid. The period given is an average for the latter part of August and early September.

Larva

The larva (Plate 3, Fig. 9) on hatching is, except for the mouth parts, a uniform whitish color and but little more than .6 of a mm. in length. Since it has the proportions and other characters of the later larval instars, it is unmistakable at all times. After eclosion the larva worms its way by aid of its pseudopods through the cambium, not being confined in its wanderings to the egg galleries or larval mines. It will feed not only on living larvae it runs across, but dead ones as well, for larvae have been reared from less than 3 mm. in size to nearly 6 mm. solely on dead Dm larvae. Medeterus larvae can not be reared on decaying vegetable

matter; this was demonstrated by placing larvae on "sour sap" cambium, as well as on cambium tissue from recently killed Dm trees. On this vegetable diet some of the larvae increased nearly a millimeter, though later shrinking to less than their former size; others showed no mentionable growth, but all died after five or six weeks. If the experiment shows that the larvae can not be sustained by cambium tissue, it also shows that the larvae are capable of sustaining themselves a fair period without other nourishment than water. If reared in the laboratory they must be kept in separate phials, for if two or more are placed together there will, after a few days, be but one, and that one fat, sleek, and considerably larger. On one occasion two larvae were observed in "mortal combat", each attempting to feed on the other. Frequently they would come together head-on, with the anterior part of the body in the air, pushing against each other until one gave way. The whole affair was unusual, for commonly when a larva comes upon another, one moves off with dispatch, and only by one getting its mouth parts in first is it enabled to feed on the other. In the above case the larger one conquered and was left peaceably feeding on the smaller, which lost its activity in a surprisingly short time.

Medeterus larvae, it seems, find their prey fortuitously. In the field laboratory they have been observed to pass by Dm larvae and larvae of their own species .1 of a mm. distant, giving no indications of sensing the other's presence. When one Medeterus larva runs into another of its own species, both of them appear startled and one of them rapidly crawls away. When a beetle larva is bumped into, the predator backs up a bit. If it proceeds ahead again it occasionally passes under the Dm larvae, completely ignoring it; at other times the Dolichoped larva "feels" to the right and left, then passes on, while less frequently it stops to feed. Feeding is done by piercing the cuticle of its host with the lance-like mandibular sclerites (Plate 3, Fig. 9) by which it is enabled to suck up the larval juices.

Under artificial conditions the predators were never observed to consume completely the larva on which they started to feed. Whether it is due, perhaps, to a passing whim, or having had enough nourishment for the time being, they would seldom feed long. In the phial, of course, the partially-consumed larvae would be chanced upon again, fed upon for awhile longer until in the end they would be reduced to nothing but their integument. These that have been fed upon for but a short while bear the same appearance as those "mummified" by Coeloides sp. This may explain the fact that in the field beetle larvae are found on which neither parasite eggs nor parasite larvae could be found, but which looked embalmed.

Medeterus larvae are much more abundant in Dm infested trees in the fall of the year than they are the spring following the attack. A few counts made six weeks after the beetle attack showed an average of over five per square foot, whereas counts made the following season between

June 4 and July 26 of 113 square feet showed an average of only about 1.1 per square foot. (Two factors may account for this distinct drop: (1) pupation in Dm 28 trees appears to occur chiefly between June 21 and July 19; and (2) cannibalism. The second factor appears to be the principal one for the average between June 4 and June 21 for 58 square feet is but about 2 per square foot.

Pupa

The predator larvae overwinter as such and pupate during the following spring. Before pupation they spin delicate cocoons between the wood and bark which at times are closely enough woven to be mistaken, if care is not used, for partially-spun Coeloides sp. cocoons. The pupa (Plate 3, Fig. 29) is free and may be easily distinguished from other free pupae by the two long respiratory horns that arise from the dorsal and anterior part of the thoracic region, as well as by the single row of spines on the first seven abdominal segments.

The pupal period for two pupae was between 12 and 16 days. The records for these two indrtiduals will be found in Table XII, line 3 and 5. As none of the pupae collected in the field had a stadium of more than the maximum period for the definitely known statia, 16 days is probably as long a time as any of the pupae require before transformation.

Table XII below gives the dates that pupae or larvae ready to pupate within cells were observed; time of observation, and year of attack of the tree in which they were observed.

Table XII

Stage	Date of Collection or Observation	Date of Beetle Attack	Remarks
Pupae (2)	July 14, 1928	1927	Emerged by July 16, 1928
Pupae (3)	Aug. 2, 1928	1927	1 emerged Aug. 4; 2 Aug. 7, 1928
Pupa	Sept. 12, 1928	1928	
Larva	May 4, 1929	1928	Pupated between May 7 and 8, 1929; emerged between May 22 10 p.m. and May 24, 2 p.m.
Pupa	May 7, 1929	1928	
Larva	May 11, 1929	1928	Pupated between May 18 and 21; emerged June 2 in laboratory.
Pupa	May 18, 1929	1928	Three observed.
Pupa	May 20, 1929	1929	Emerged May 24 in laboratory.
Pupa	May 29, 1929	1927 or 1928	
Pupa	June 5, 1929	1928	First adult found in field.
Pupa	June 12, 1929	1928 and 1927	Very common.
Prepupa	June 17, 1929	1928	
Pupa	June 20, 1929	1928	
Pupae (3)	June 21, 1929	1928	One empty pupal case observed.
Pupae (6)	June 27, 1929	1928	
Pupa	July 8, 1929	1928	Three adults also reared from Pm yellow pine between June 30 and July 8.
Pupa	July 18, 1929	1928	All three stages of Medeterus found in or on this one tree.
Pupae (7)	July 19, 1929	1928	Empty pupal case observed.
Pupa	July 28, 1929	1928	

While the above table shows that pupation occurs over the entire season, data secured during 1929 by counts between June 4 and July 26 of 113 square feet on 23 Pm 28 trees, indicate that pupation occurs chiefly between June 21 and July 19.

Economic Status

There is hardly any question that the larvae of Medeterus aldrichi Wh., because of their destruction of the eggs, larvae, and rarely pupae of the mountain pine beetle, are second only to Coeloides sp. in economic value. But since the survival potential of the most of the brood they destroy is low, their value is reduced.

The number per square foot during the spring of 1929 averaged about 1.3 (Table XIX) but it is difficult to determine the amount of beetle brood each one destroys. In an attempt to secure some figure for this amount, an experiment was tried of caging with fine mesh wire screen 15 feet of the bole of three healthy lodgepole pine (Plate 6). Into each of the cages a sufficient number of Dm adults were introduced to cause an average attack in the area caged. Two weeks later 50 female Medeterus and as many males as possible were to be introduced into two of the cages, the remaining one to be used as a check. Counts were then to be made later in the fall and the following spring of the Medeterus and Dm larvae. As, unfortunately, the beetles concentrated at the base of the cages, causing the decidedly abnormal condition of 30 or 40 attacks per square foot, the experiment was not completed.

An accurate estimate of the brood destroyed by the larvae would be difficult to make, but as it is known that the Medeterus larvae often feed for but a short time on Dm larvae and then move on, the number a single one destroys is probably appreciable. From the time of hatching until pupation an average larva might kill perhaps 10 Dm larvae.

XYLOPHAGUS* ABDOMINALIS Loew.

(Diptera - Leptidae°)
Predator

Among the diptera, next to Medeterus, Xylophagus is the most important predator of Dm larvae. They do not, unfortunately, confine their attacks to larvae of the mountain pine beetle but feed on any available subcortical insect forms. The few observations made on the habits and seasonal history of the fly indicate that there is one generation a year, with pupation and emergence occurring in the spring.

Adult

The adult flies (Plate 3, Fig. 30) vary between 10 and 16 mm. in length. The rather robust body is nearly black but with a reddish area on the disk of the first two or three abdominal segments; the legs, straw colored, and the wings somewhat dusky with several lighter areas.

* For complete description of this and other species of Xylophagus cf. Mallock, J.R. "Preliminary Classification of Diptera"; Bull. of the Ill. State Laboratory, 1917, and Greene, C.T. "Descriptions of Larvae and Pupae of Two Winged Flies belonging to the Family Leptidae", Proc. U.S.N.M. vol. 70, #2651, 1926.

°Some authors place this genus in a separate family - Xylophagidae.

The first adults were found June 5, 1929, resting on the base of a lodgepole pine attacked the previous season. They were found up to July 8, 1929, on Dm 28 attacked trees and though we have no record after that time, adults could probably have been found at a much later date. The imagines are not very active; often remaining motionless for five minutes or more on the bark; their flight is slow and heavy.

The manner of oviposition has never been observed but their eggs when found have been in the main galleries of the barkbeetle.

Egg

Of 25 eggs (Plate 3, Fig. 5) measured the average length was 1.44 mm.; maximum 1.53 mm.; minimum 1.35 mm. The average width of the same eggs was .26 mm.; maximum .27; minimum .23 mm. The surface of the egg is uniformly covered, except at the extremities, with small ridges arranged in honeycomb fashion. At the ends the ridges are more pronounced and appear to be in no regular arrangement. In shape the eggs are somewhat like a miniature banana; when first laid they are a dark red in color but after a day gradually become brownish.

Table XIII below gives the data obtained concerning the egg period.

Table XIII

Showing Egg Period* of Xylophagus

Date Laid Between 1929	No. Eggs	Hatched Between	Period in Days	Remarks
June 11 - 10 a.m. and 13 - 11 a.m.	5	June 21 - 9 a.m. and 22 - 10 a.m.	11	
do	1	June 22 - 10 a.m. and 23 - 11 a.m.	12	
June 13 - 8 a.m. and 15 - 8 p.m.	2	June 22 - 5 p.m. and 24 - 5 p.m.	11½	Two other eggs laid same time did not hatch.
June 15 and 17	12	June 25 and 26	11	68 other eggs laid same time, were alcoholed after the 12 had hatched.
June 16	?	June 23 - 2.45 p.m.	8½	No. of eggs not counted but about a half dozen.

* Eggs in laboratory entire period.

The period required for hatching appears to be between 7½ and 12½ days.

Larva

Length 1.35 mm. first instar; 2.4 mm. mature larva; elongate, cylindrical; body, ivory white; head longer than wide, dark reddish brown to nearly black.

Larvae of the first instar (Plate 3, Fig. 7) are slightly longer than the egg from which they emerge. The average length of seven individuals was 1.66 mm.; maximum 1.9; minimum 1.35; average width .21 mm. They differ from the later instars (Plate 3, Fig. 8) by having (1) a uniformly tapering head capsule; (2) by the absence of sclerotization on the thoracic segments; and (3) by the presence of but a single bristle on each side of all the body segments save the first thoracic, which is bristleless and the terminal which bears five on each side, four being on the caudal plate. The later instars are characterized by having (1) an abruptly restricted head capsule (Plate 3, Fig. 8); (2) entire, or almost entire, sclerotization of the terga of the first two thoracic segments, the third with a variation from two small spots on each side to three larger areas, or complete sclerotization; and (3) by the presence of more than one bristle on all the pleura of the body. The number of bristles other than on the pleura appears to vary with succeeding instars but sufficient material is not at hand to determine this definitely.

All of the larval instars* agree in having 11 segments, beside the head; an anterio-dorso-ventral band of locomotor spines, not extending to the lateral margins of the body, on the first six abdominal segments, but on the seventh abdominal segment only an anterio-ventral-band; a heavily sclerotized dorsal plate, bifid posteriorly, on the caudal portion of the terminal segment; and a reddish, strongly sclerotized pair of spiracles on both the first thoracic and the last abdominal segments.

The larvae work between the wood and the bark, feeding on any insect larva chanced upon. They feed by piercing the insect cuticula with their sharp mandibles, and sucking out the body fluids.

Previous to June 27, 1929, larvae were found only in Dm 26 and 27 attacked trees. In this last group they were occasionally observed feeding on cocoon-enclosed Coeloides sp. larvae, while in one instance one larva was found feeding on an Aulonium larva. On June 27 a few small Xylophagus larvae were found in a Dm 28 tree, and after that date they were not uncommon in this type of tree. Larvae hatching from eggs laid in Dm 28 trees probably overwinter as such and pupate in the spring. No pupae have ever been found in trees attacked the year previous.

*For detailed descriptions of the mature larva cf. both Malloch and Greene, l.c.

Pupa

The average length of five pupae was 15 mm.; maximum 20 mm., minimum 12 mm. They are cylindrical in shape (Plate 3, Fig. 31) and straw colored in appearance.

Pupae have been found only during June in the trees attacked by the beetle not less than two years previously. In the field the first pupa was observed June 5, 1929, in a Dm 27 tree. In the laboratory a larva collected from a Dm 27 tree on May 4 pupated between May 23 and 24; the adult emerged between May 31 and June 1, 1929; a maximum period of eight days.

Economic Status

It is doubtful if the larvae of this species are of any appreciable value in controlling the mountain pine beetle. It is known that the fly larvae prey on Coeloides sp. larvae and probably other insects beneficial as predators of Dm. Therefore, their value as destroyers of the beetle larvae may be balanced or perhaps over-balanced by their harmful habits. Of 64 square feet of bark examined between June 27 and July 23 on 13 Dm 28 trees, but 11 Xylophagus larvae were observed -- an average of one-sixth per square foot. Their scarcity is sufficient to prevent them from being regarded as of prime importance.

Occurrence

Besides being found in Dm attacked lodgepole pine, they are found in Dm attacked yellow pine and white pine and in the galleries of Orthotomicus and probably Ips in lodgepole, and in the galleries of Scolytus in Abies grandis and A. lasiocarpa.

(1)

LONCHAEA VIRIDANA Meigen

(Diptera - Lonchaeidae)

After experimentation last year it was thought that the larvae of this fly were not predacious on the eggs and larvae of the mountain pine beetle; as those employed last year totally ignored both eggs and larvae. Further experimentation was on the way to verify the previous observations when in several instances Dm eggs which were placed with Lonchaea larvae were found to have disappeared and healthy beetle larvae

(1) Some authors place this genus in the Sapromyzidae.

in the same position were, the following day, found to be dead. However, the total observations on the habits of the larvae of this fly lead me to believe that they are not usually predacious on the immature forms of the mountain pine beetle.

Larvae under the conditions in which Lonchaea is commonly found, i.e., moist, decaying cambium, are believed by Malloch (2) to be both saprophagous and predacious. He is quoted below:

"The larvae (Neopachygaster maculicornis Hine) feed upon decaying matter under slightly loosened bark, but also, occasionally, on other dipterous larvae -- as those of Lonchaea polita, which are found among them. Lonchaea larvae often eat other larvae and pupae.....in fact the dipterous larvae found under bark conditions suitable for Stratiomyiidae appear to be almost without exception alternately predacious or saprophagous. They may be able to live entirely upon the sap and slightly decayed vegetable matter under the bark but I suspect that the main food supply consists of excreta, exuvia, or the bodies of coleopterous larvae that occur there. That they feed upon each other I have often proven by personal observation."

The adults lay their eggs from late May or early June not only in Dm-killed trees but Ips oregoni and probably barkbeetle-infested tops and branches.

Adult

The imago (Plate 3, Fig. 27) about 4 mm. in length and of a metallic blue-green lustre, is found on Dm-infested lodgepole within a few weeks of the attack. The female moves over the bark in a more methodical and business-like manner than Medeterus, and unlike it uses ventilation holes and similar openings in which to deposit her eggs. On finding a suitable orifice she either walks beyond it or turns around until the tip of her abdomen can be inserted, then backing in she disappears from sight. The eggs usually are laid in juxtaposition but form a single layer on the inner surface of the bark a short distance from the place of entrance. Records of two individuals show that in one instance 30 eggs were laid, in the other 36 eggs; in both cases the performance required exactly 9 mimutes.

The adult takes to flight in a characteristic eccentric zigzag manner, the burnished chitin glinting in the sunlight like a point of blue flame -- very different indeed than Medeterus which suddenly arrives from nowhere on the bark surface before one to vanish a few seconds later

(2) Malloch, J. R. (loc. cit.).

as mysteriously as it appeared. On the other hand, the Coeloides sp. flight is more prosaic than either of the flies, for it approaches a tree in a more or less direct line with a wing vibration slow enough to be caught by the eye.

Egg

The egg (Plate 3, Fig. 3) a creamy white, hatches 5 to 6 days after being laid. Table XIV below shows the data obtained concerning them.

Table XIV

No. and Place Laid	Date Laid	Hatched by	Hours	Av. Length mm.	Av. Width mm.
I.o. tree 7	Aug. 6, 1928 11:50 a.m.	Aug. 11 9:35 p.m.	129½	--	--
Dm 28 tree 30	Aug. 25 12:56 p.m.	Aug. 30 1:45 p.m.	127 1/3	.819	.158
Dm 28 tree 36	Aug. 27 4:41 p.m.	Sept. 2 11 a.m.	138 1/3	.773	.18

Larva

The whitish larvae (Plate 3, Fig. 6) that emerge from the eggs average about 1 mm. in length and .15 mm. in width at the middle, but are wider posteriorly and narrower anteriorly than at the middle, and the caudal spiracles occur at the upper end of the last segment. It is by these characters they may be distinguished at all times from Medeterus larvae which they superficially resemble. The Lonchaea larva, unlike the Medeterus larva, is not only capable of entirely withdrawing the head within the first thoracic segment, but also of retracting the mandibular sclerites within the head capsule. When in motion the larva has a peculiar manner of elevating the anterior part of its body and then slapping it down on the supporting surface. By doing so it apparently forces the mandibular hooks (Plate 3, Fig. 6 ms) into the tissues, thus enabling it perhaps to pull itself along more easily. The larvae are not confined to the Dm larval galleries nor in the region between the wood and bark, but are found more commonly in the inner bark through which they move with apparent ease.

The complete larval history is not yet determined but it is known that most of them overwinter as such and pupate not earlier than about the middle of May. Others apparently feed for a considerable time before pupating.

Larvae are also found during August and September in trees killed the previous year. Thus it appears that the females do not confine their ovipositing to newly-killed trees, and the fact that larvae feed mostly on decaying organic matter makes it seem reasonable to expect to find them in Dm-killed trees as long as there is decaying cambium.

Pupa

The pupa (Plate 3, Fig. 32) is coarctate, the indurated skin a reddish-brown, and averages for 7 specimens 4.8 mm.; maximum 5.1, minimum 4.3 mm. in length; all were 1.6 mm. in width. As it is approximately the size and shape of several other puparia found under the bark of the dead lodgepole, care must be taken not to mistake puparia of other species for it.

From the various months that puparia were found it seems that Lonchaea viridana overwintering as larvae in trees attacked the previous year pupate from the latter part of May to the end of June. The first puparium was found May 14. Table XV gives the various data on which pupae or prepupae have been observed and the dates of emergence.

Table XV

Stage	Date of Observation (O) or Pupation (P)	Year of Beetle Attack	Emergence on or between
Pupal	May 21, 1928 (O)	1927	May 25, 1928
Pupal	May 14, 1929 (O)	1927	-------
Pupal	May 21, 1928 (O)	1927	June 2, 1929
Pupal	June 21, 1929 (O)	1928	-------
Pupal	June 24, 1929 (O)	1927	June 25-26, 1929
Prepupal	June 25, 1929 (P)	1927	July 8-9, 1929
Pupal	June 26, 1929 (O)	1928	-------
Pupal	June 27, 1928 (O)	1927	July 10, 1929

Economic Status

While the larvae of this insect are considered of little economic importance as a controlling agent of Dm brood, mention of their relative abundance may be of interest. Counts made between June 4 and July 26, 1929, of 113 square feet of bark surface from 23 Dm 28 trees showed an average of .47 per square foot.

GLISCHROCHILUS VITTATUS (Say)

(Coleoptera - Nitidulidae)

The adults and the larvae of this species were believed to be saprophagous but a study of their habits the past season indicates that they will also feed on the eggs and larvae of the mountain pine beetle. They are probably both saprophagous and carnivorous. Their complete seasonal history is not known.

Adult

The adult (Plate 1, Fig. 17) is a small black beetle about 5 mm. in length with each of its wing covers generally bearing five yellowish spots, of which three are distinct, the other two somewhat faint. There is great variation among individuals, on some but three spots are visible, on others but two, the first and second joining each other to form one long one. The mature form can be found, except perhaps the first month after the new attack, at any time of the year in lodgepole infested by the mountain pine beetle; but they are also found in trees many months after the beetle brood has emerged. Though the adults frequent the main galleries of the mountain pine beetle that are free of frass, or occasionally when the bark is somewhat loose work their way into nearby larval pits, they are most commonly found where a "sour sap" condition of the bark obtains. Whether they are attracted by the decaying cambium or by other insects found in the sour sap, or both, was not determined; neither was their carnivorous nature, which under artificial conditions has been proved, verified in the field. The field notes and Table XVI given below demonstrate their habits under laboratory confinement.

Field note dated May 29, 1929:

For past several days 1 Dm larva has been added each day to a vial containing 2 Glischrochilus adults. Each day the Dm larva added the previous day could not be found. Today a Dm larva was added about 11 a.m. -- 4:30 p.m. no sign of larva. Another healthy Dm larva was then added; in less than 1 minute both Glischrochilus adults were chewing voraciously on the Dm larva.

Table XVI

Record Showing Dm Eggs and Number of Healthy and Active Larvae Fed to Four Glischrochilus Adults Kept in Rearing Vial

1929 Date Dm larvae added	No. of Dm Larvae or Eggs Placed in Vial		Time of Next Observation and Condition of Dm Larvae or Eggs
	Larvae	Eggs	
May 18	2		May 20, no sign of 1 larva, other active, and remained healthy and active till May 28 when it could not be found.
May 28	1		May 29, could not be found.
May 29	1		May 29, 4:30 p.m. could not be found.
May 29	1	2	May 30, larva and 1 egg gone; other egg O.K. and did not disappear until June 3.
May 30 (9:30 a.m.)	1		May 30, 5:30 p.m. dead.
June 3	1		June 3, feeding on it within 2 seconds after being added. No sign of it June 4.
June 5	1	2	June 6, eggs gone, larva dead.
June 7		2(4 p.m.)	June 7, 4 p.m. adults crawl over eggs paying no attention to them. June 8 eggs still O.K.
June 8	1		June 10 larva O.K. but eggs added June 7 gone. June 11 larva dead.
			June 14 Glischrochilus adults look ill. Most of them dead June 22. Experiment concluded.

One must assume the hypothesis that the larvae and eggs that could not be found were devoured by the Glischrochilus adults and such, after witnessing the feeding on several occasions, is what I believe occurred, especially as there seems to be no other alternative to which one may turn. Therefore, the beetles accounted for 6 Dm eggs and 9 larvae in 23 days; however, 6 or 7 of these days the beetles did no feeding; consequently, they actually consumed the Dm eggs and larvae in 15 days. No mean appetites it appears when each Dm larva added probably weighed as much as the 4 beetles combined.

Though they are believed to be normally predacious and they certainly do not dislike Dm larvae or eggs, still because of the mechanical difficulties it is hard to imagine their feeding on Dm larvae or eggs except in rare cases. The adults do not appear to be able to move under the bark except in open galleries or where the bark has become slightly loosened. Since the barkbeetle adult in most cases packs her egg galleries rather tightly with frass, and the bark around the larvae is seldom loose, the chances of the nitidulid being of importance as a direct predator must be decidedly slim.

Egg

Glischrochilus eggs (Plate 2, Fig. 1a) were never observed in the field, but in the laboratory two eggs were laid by one female between June 13 and 14, 1929. They were a uniform translucent white; their surface was slightly shining and bore no distinct markings; their shape was that of an oval slightly flattened in the mid area; each of them was 1.17 mm. long and .36 mm. wide. As, unfortunately, neither of the eggs hatched, both turning brown and becoming flaccid by June 26, 1929, we have no idea of the egg period.

Larva

The mature larvae (Plate 2, Figs. 1, 1b and 1c) are about 9 mm. in length, a little less than 2 mm. in width with the sides nearly parallel, but tapering very slightly towards each end; flattened dorso-ventrally; and yellowish white in color. The body, exclusive of the head, is composed of 12 segments; all but the first and third thoracic segments bear a pair of slightly raised spiracles, and the tergum of the first thoracic segment bears two large brownish sclerotized areas which are lacking on the other segments. The terminal segment bears a pair of bifurcate cerci (Plate 2, Fig. 1c).

The characters of the earlier instars are not known. Glischrochilus larvae were not found until the last week of May, but it is believed that smaller larvae could be secured a week or two earlier. They are found in much the same habitat as the adult, though perhaps more commonly in "sour sap" areas.

While the larvae have never actually been observed feeding on Dm larvae either in the field or in the laboratory, it is believed that they are predacious, at least occasionally. The following field notes dated July 16, 1929, and tabulated below in Table XVII are the basis for this belief.

Table XVII

Showing Number of Dm Larvae Added to Vial Containing Five or Six Glischrochilus Larvae

Date Dm Larvae Added 1929	No. Dm Larvae or Eggs Added: Larvae	Eggs	Date of Next Observation and Condition of Dm Larvae
June 11	1		June 12 no sign of Dm larvae.
June 12	1		June 13 not much left of Dm larva; 1 Glischrochilus larva looks fed on as well.
June 13		2	June 14, no sign of eggs. Remains of Dm larva gone.
June 14	1		June 15, no sign of Dm larva.
June 18	1		June 19. no sign of Dm larva.
June 19	1		June 20, " " " " "
June 20	1		June 21, " " " " "
June 21	1		June 22, " " " " "
June 22	1		June 24, " " " " "
June 24	1		June 25 " " " " " Only 4 Glischrochilus larvae present.
June 25	1		June 26, Dm larva pupated. June 27, Dm pupa fed on. July 6, all Glischrochilus larvae dead.

There is no doubt in my mind that the Dm larvae which could not be found after being placed in the vial were devoured by the Glischrochilus larvae. Though we have no more data to back up the results described above, there seems to be no reason to believe that the cases of feeding were abnormal.

The occurrence of the larvae is rather general; 120 were recorded from Dm 28 attacked lodgepole in 113 square feet of bark surface examined between June 4 and July 26, 1929. The entire number, however, were listed between June 20 and July 20 from 83 square feet of bark surface -- an average of practically 1.5 a square foot.

Pupa

The pupa is practically the same color as the larva but considerably shorter in length; only two measurements were taken, both of which were 4 mm. This stage resembled in appearance a shortened larva and the moulted larval skin remained fastened to the end of the abdomen more securely than was usually the case with observed coleopterous pupae.

If a limited period occurs during which a general pupation takes place it was not determined. But two records of pupation are available; in one instance a larva collected in the field July 17 in a Dm 28 tree pupated between August 17 and 19 (prepupa 14, 15, 16, and 17) and transformed between August 27 and September 8, 1929; in the other instance a larva collected July 20 in a Dm 28 tree pupated between August 5 and 14 (prepupa 4, 5) and transformed between August 17 and 20, 1929; a possible maximum of 20 days in the former case and 13 days in the latter case. Pupation probably occurs under the bark.

Occurrence

The species is also found in Dm infested yellow pine and in the galleries of Ips oregoni.

Economic Status

Though known to be predacious there have been no indications that they are of more than slight value as controlling agents of the mountain pine beetle brood. Counts made between June 4 and July 26, 1929, of 113 square feet of bark surface from 23 Dm 28 trees showed an average of 1.1 larvae and .03 adults per square foot.

HYPOPHLOEUS PARALLELUS Melsh.

(Coleoptera - Tenebrionidae)

The adults of this species have been found to be occasionally predacious on Dm larvae, but their larvae as yet have exhibited no signs of having this habit. Both forms are found under the bark in the galleries of Dm soon after the beetle attack and for at least two years longer. They are of no direct economic importance in the control of the beetle brood in lodgepole pine.

A brief description of what is probably a new species of this genus will be found in Part II of this report.

Adult

Average length 4.0 mm.; width 1.8 mm.; color, uniform brown; surface shining, rather uniformly covered with small rather shallow pits.

The adults (Plate 1, Fig. 3) are often seen moving rapidly over the bark of infested trees, crawling into bark crevices, or disappearing through ventilation holes made by barkbeetles. They are usually found in egg galleries and apparently act as scavengers, though the data in Table XVIII below indicate that they will feed on Dm larvae. Struble,* working with H. substriatus Lec. in California, reared larvae through to the adult stage on pure cultures of fungi but was unable to secure any indication of H. substriatus being predacious in habit.

*Struble, G. R. The Biology of Certain Coleoptera Associated with Bark Beetles in Western Yellow Pine. Univ. of California Pub. in Ent. Vol. 5, No. 6, 1930.

Table XVIII

Showing the Number of Dm Larvae Fed to Hypophloeus Adults

1929 Date Dm Larvae Added	No. of Dm Larvae Added	Date of Next Observation and Results
May 20	2	May 21, 22, 23, 24, 25, 26 Dm larvae active, untouched. May 28 Dm larvae dead and beetles feeding on them. May 30 no sign of Dm larvae added May 20.
May 30	1	May 31 no sign of Dm larva.
" 31	1	June 1 " " " " "
June 1	1	" 3 " " " " "
" 3	1	" 5, 6, Dm larva active. June 7 no sign of Dm larva.
" 7	2 (Dm eggs)	June 8, one egg fed on other O.K.
" 8	1	" 10, 11, 12, 13, 14, 15, 16, 17, larva gradually dying. No sign of being fed upon, 18 dead. Egg added June 7 still O.K.
" 19	1	June 30 Dm larva still O.K. July 6 no sign of egg added June 7. July 21 Dm larva added June 19 dead.

The notes above show that while the adults are not very actively predacious they do occasionally feed on living larvae.

Though the adults are frequently found on trees the same season as the attack they are most common during the latter part of May following the Dm attack.

Egg

~~One egg~~ (Plate 2, Fig. 8a) of Hypophloeus was secured; length .848 mm.; width .45 mm. Its color was whitish, and it bore no distinct surface markings. The egg was laid between June 18 and 19, 1929, and hatched between June 27 and 28, a maximum of 10 days. In the field the eggs are probably laid under the bark.

Larva

The first instar larva reared from the above described egg measured 1.3 mm. in length. The body was composed of 13 segments, including the head; its color after a few days was much like that of the later stages, i.e., all segments somewhat brownish and sclerotized more towards the caudal portion of each segment. The thoracic segments were narrower than the abdominal segments, but this character is not as noticeable in the later stages. The older instars do not differ appreciably from the first instar save in size; that of the mature larva being about 7 mm. in length. It differs from most of the coleopterous larvae by being light brown on all segments and lacking cerci. Its characters can best be seen by an examination of Fig. 8, Plate 2. The habitat of the larva is the same as that of the adult, but the larvae seem to be more abundant in trees the year after the Dm emergence. No definite data have been secured concerning the feeding habits, but none as yet has been observed to be predacious.

Pupa

The pupa is yellowish white, considerably lighter in color than the mature larva, and unlike the larva bears a pair of hooked cerci or cerci-like appendages. The pronotum is fringed on the two lateral margins with hairs about 1 mm. long; the anterior margin has somewhat shorter hairs, while the posterior margin bears few or no hairs.

Pupation occurs under the bark in no specially constructed cell.

Table XIX below contains the data secured concerning the pupal stage.

Table XIX

1929 Date Collected and Year of Dm Attack	Date Pupated	Length in mm.	Date Transformed between
June 17 - Dm 27	July 10	--	July 18 and 19
June 17 - Dm 27	July 15 and 17	3.7	Did not transform
June 27 - Dm 27	Collected as pupa	-	July 1 and 6
July 16 - Dm 28	" " "		July 19 and 20
July 16 - Dm 28	" " "	3.9	Preserved
July 16 - Dm 28	" " "	3.3	"
July 16 - Dm 28	" " "	3.9	"

Of only one pupa, the first in the table, was the entire statium obtained. This was between 8 and 9 days.

Economic Status

Of no appreciable importance as controlling agents. Counts made between June 4 and July 26, 1929, of 113 square feet of bark surface from 23 Dm 28 trees showed .009 larvae and .05 adults per square foot.

MYCETAEA LINEARIS Mäkl.

(Coleoptera - Nitidulidae)

Neither the larvae nor the adults of this species are believed to be predacious on the brood of Dm larvae. While several adults have been observed feeding on a Dm larva within a rearing vial, they probably began feeding after it had died as other living Dm larvae and eggs placed with the same adults were untouched after several weeks.

Adult

Length between 2.3 and 3.6 mm.; head brown, rarely with a darker area in middle. Antennae generally darker than head, especially the two distal segments which are also larger than the other segments; thorax brown occasionally, with darker area in middle, uniformly smooth, without distinguishing characters; scutellum distinct, large, flush with surface of elytra; elytra brown, apex frequently darker than base; surface smooth, lacking striae, deep pits, or ridges. Head, thorax, and abdomen uniformly covered with recumbent hairs arising from small very shallow pits. Legs color of prothorax, all joints same color. Metasternum always darker than legs; ventral surface of abdomen color of legs or may occasionally be darker. See Plate 1, Fig. 13.

Egg

Not known.

Larva

The mature larvae (Plate 2, Fig. 6) are about 6.5 mm. in length. Body yellowish with a double row of large brown rectangular areas on dorsum of each segment save the last segment which bears a single larger plate in the center; head brownish, somewhat triangular, upper surface marked by a light line in shape of an eye; ocelli, two large and distinct ones at base of each antenna, two smaller and indistinct ones slightly behind each set of large ocelli (Plate 2, Fig. 6a); terminal segment with a pair of upturned immovable cerci.

Pupa

But one pupa was secured. This was reared from a larva collected in a Dm 27 tree June 22, 1929; it pupated between June 30 and July 6, and transformed between July 13 and 14 -- a maximum of 8-14 days. The pupa had two small spines on anterior part of prothorax. Pupation probably occurs under the bark.

Occurrence

Larvae and adults found under bark in egg galleries of Dm from about one month to at least two years after the beetle attack. This is a fairly common species found also in Dm infested yellow pine, in the galleries of Polygraphus rufipennis in spruce, and the galleries of Orthotomicus in lodgepole pine.

Economic Status

None -- feeds chiefly on decaying or souring cambium, rarely, on Dm brood. Counts made between June 4 and July 26, 1929, of 113 square feet of bark surface from 23 Dm 28 trees showed an average of .035 larvae and .03 adults per square foot.

RHIZOPHAGUS PROCERUS Csy.

(Coleoptera - Rhizophagidae)

The adults of this species are known to be predacious at times on the eggs and larvae of Dm. The habits of the larvae are not known. Both stages have been secured the first, second, and third season after the mountain pine beetle attack, under the bark in the Dm egg galleries, and, where the bark is somewhat loosened, for a considerable distance in from the galleries. The adults are occasionally found in groups of 30 or 40 feeding together on secretions, or growths, or the decaying cambium. Seven adults have been observed feeding in a group on a larva of Dm.

This species is of negligible value as a controlling agent of the brood of the mountain pine beetle.

Adult

The average length of the adults (Plate 1, Fig. 1) is 3.6 mm.; maximum 4.0 mm.; minimum 3.0 mm.; head brown, sculpturing of evenly distributed obovate punctures; antennae color of head, clubbed; pronotum generally darker brown than the head, but with lighter areas at base; elytra smooth except for eight rows of punctures, the first row (stria) impressed towards the apex of elytron; pygidium distinctly exposed.

Egg

An egg, that was probably laid by this species, was collected under the bark of a Dm 28 yellow pine June 7, 1929. Length .81 mm.; width .29 mm.; color translucent white with tinge of yellow. (Plate 2, Fig. 4a). The egg hatched between June 10 and 11.

Larva

The length of the first instar larva, ~~from above mentioned egg~~, ~~was~~ .98 mm. It resembled the mature Rhizophagus larvae. The mature larvae (Plate 2, Fig. 4) are about 5.5 mm. in length; color whitish with a yellow cast; no pronounced markings on dorsum of any segment save the terminal which bears a pair of fixed cerci, hardened only at the tips (Plate 2, Fig. 4b); ocelli, two at base of each antenna; spiracles indistinct, a pair between the pro- and mesothorax and on each abdominal segment.

Pupa

Not known.

Occurrence

The adults and larvae are also found in the galleries of Dm in white-barked and yellow pine and in the galleries of Ips, Orthotomicus, Scolytus, Dryocoetes, and Hylurgops.

Economic Status

The species is of no importance as a controlling agent of the barkbeetle brood. Counts made between June 4 and July 26, 1929, of 113 square feet of bark surface from 23 Dm 28 trees showed an average of .09 larvae and .065 adults per square foot.

LASCONOTUS COMPLEX Lec.

(Coleoptera - Colydiidae)

There are three species of this genus found in association with Dm under the bark of lodgepole pine. This species, however, is the most common and will be the only one treated in detail. / Description and distinguishing characters of the other two species will be found in Part II of this report. Any succeeding reference in this section to Lasconotus refers to L. complex as practically nothing is known concerning the habits of the other species.

The adults were found to be predacious on Dm eggs and larvae in the laboratory; no definite information was secured regarding the larvae. Under natural conditions the adults may occasionally be destructive to Dm brood but observations show that they are saprophagous as well.

The genus is of practically no importance in the natural control of Dm.

Adult

The adult insect (Plate 1, Fig. 5) ranges in length from 3-4 mm., average about 3.8 mm., average width at base of elytra 1.5 mm.; color uniform dull Van Dyke brown; pronotum with two ridges on each side and a large shallow depression in center; elytron with three acute longitudinal ridges each separated by a double row of pits.

Lasconotus are found under the bark of Dm infested trees from shortly (usually less than a month) after the Dm attack, to the following July, and perhaps longer. They are more common in the fall and early spring though at no time are they especially abundant.

Adults have been collected in the field feeding on the larvae of Dm; in the laboratory while they were never seen feeding on the larvae those placed in a vial containing Lasconotus adults were usually missing the day after they were added. Individuals of this genus have, however, been observed in the laboratory feeding on Dm eggs. The following field notes dated June 11, 1929, were made at the time of the above observation.

> Three Dm eggs were added to a vial containing 8 or 10 L. complex adults. Two beetles crawling around (the others were inactive, clinging under pieces of cambium) chanced upon the eggs (or were they attracted to them?). One picked up an egg in its mandibles, walked a short distance, then dropped it. The other spent about 30 seconds trying to pierce the chorion of another egg before finally succeeding. But as soon as this beetle was "seen" feeding, all the others crowded around it, and on top of each other attempting to feed, as flies on a spot of jam. Shortly after another egg was pierced and as quickly devoured. The remaining egg has been in the vial about 15 minutes, and though every time a beetle passed by, the egg was given a couple of "chews", it has not yet been punctured. If the beetle can not rupture the shell after a few attempts it drops the egg and moves on.

Though the adults appear to be generally predacious they have been observed feeding on decaying cambium in the rearing vials, and they have been kept alive without animal matter for over a month.

Egg

The egg (Plate 2, Fig. 9a) resembles a Dm egg in color but is more elongate and slightly smaller in size. Table XX below gives all the data concerning the eggs observed.

Table XX

1929 Date Laid Between	Length in mm.	Width in mm.	Date Hatched on or Between
Before June 13	.99	.36	June 18
" " 13	.95	.27	Did not hatch
June 13 and 14	.81	.36	" " "
June 13 and 17	.86	.28	" " "
Not known	.90	.32	July 6 and 8

The eggs are laid under the bark.

Larva

The mature larvae (Plate 2, Figs. 9, 9b, and 9c) average in length 5.5 mm.; color whitish with head brown; the dorsum of the terminal abdominal segment strongly sclerotized and roughened, and bearing a pair of upturned cerci (Plate 2, Fig. 9b); the penultimate segment only partially sclerotized and not roughened; each pleurum bearing two long hairs; spiracles so small as to be scarcely discernible. The first instar differs from the latter stages by having relatively longer hairs on the body and the plate on the terminal segment is not so strongly sclerotized and roughened. The length of a first instar larva was 1.05 mm. All the stages observed have five ocelli at the base of each antenna arranged in two rows, the anterior row composed of three ocelli, the posterior row of two (cf. Plate 2, Fig. 9c).

The first larvae are found in Dm trees the spring after the attack. It seems reasonable to believe, however, that one may find them the previous fall. They are found under the bark in the same situations as the adults.

Pupa

The pupa can be recognized as belonging to this genus by the resemblance of the pronotum to that of the adult. Of two measured, one was 4.1 mm.; the other 3.5 mm. in length.

Pupation probably occurs under the bark.

Table XXI below gives the data obtained on pupae reared from larvae collected in the field.

Table XXI

1929 Date Pupated Between	Date Emerged Between	Maximum Period
July 18 and 19	July 30 and 31	13 days
August 3 and 4	Dead but partly emerged on Aug. 14	11 "
August 5 and 14	August 21 and 22	8-17 "

Occurrence

This species is also found under the bark of Dm infested yellow pine, western white pine, and probably in the galleries of other bark beetles.

Economic Status

The value of this genus as a controlling agent of Dm is very little. When counts were made for the other insects not a single larva or adult was recorded.

NUDOBIUS (XANTHOLINUS) Sp.

(Coleoptera - Staphylinidae)

A species, probably cephalus (Say), belonging to this genus is the most common of the larger rove-beetles inhabiting the underbark of Dm trees the first season after the attack. They are also found in trees abandoned by Dm for as many as three years.

Both the adults and larvae are known to be of predacious habits but neither stage has been found feeding on Dm larvae or eggs in the field; in the laboratory the adults would feed on both the larvae and the eggs of Dm as soon as they were added to the vial. There is no doubt but that both forms of this species will feed on Dm larvae or eggs when the opportunity arises, but as they most probably feed on other subcortical larvae which are likewise predacious on Dm, their value as a controlling agent of the mountain pine beetle is not great.

Adult

Length about 7.5 mm.; width at base of elytra 1.1 mm.; head, thorax, and abdomen brownish black; antennae slightly darker than legs; legs, all joints brown; elytra color of legs to slightly lighter than color of thorax. (Plate 1, Fig. 16).

Egg

Not known.

Larva

Length of mature or nearly mature larvae (Plate 2, Fig. 11) 10 mm.; width at first thoracic segment 1.2 mm.; color whitish yellow with brown head; head distinctly flattened; mandibles prominent, securiform, with no molar area; antennae prominent, 4-jointed; ocelli, one pair, a single one situated at base of each antenna; thorax and abdomen comprised of 12 segments; terminal abdominal segment bearing a pair of two jointed movable cerci.

Little more than the information given above is known of its habits. They are found under the bark in the egg galleries and occasionally where there are no galleries but whether they generally make their way under the bark if it is not loosened was not discovered.

Pupa

Elongate, head bent under thorax. It clearly resembles the adult in general facies. Pupation occurs under the bark in no specially constructed cell.

Economic Status

This species appears to be no factor in the control of the mountain pine beetle. But one individual was recprded when counts were made for the other insects.

QUEDIUS LONGIPENNIS Mann

(Coleoptera - Staphylinidae)

But two specimens of this species have been collected in Dm-infested trees. One was collected in August, 1928, under the bark of a Dm 27 tree; the other, May 17, 1929, in a Dm 28 tree. Nothing is known of its habits.

It is a large, robust insect from 7-10 mm. in length, with black body and antennae, nearly black legs, and dark reddish-black elytra. The abdomen, especially the terminal segment, is vested with rather short, coarse, densely placed hair. It can be distinguished from Nudobius by the shape of the pronotum which is wider than long (Plate 1, Fig. 12) and the coarse hairs; Nudobius has the pronotum longer than wide (Plate 1, Fig. 16) and the abdomen covered with long, fine, sparsely-set hairs.

The egg, larval, and pupal stages have not been found in beetle-attacked lodgepole.

PHLEONOMUS sp., PLACUSA sp., TACHYPORUS sp., GYROPHAENA* sp., ALEUSIS sp., LEPTUSA sp.

(Coleoptera - Staphylinidae)

Besides Xantholinus there are several other species of staphylinids found under the bark of beetle-infested trees. All of these, which are listed above, are less than 3.5 mm. in length. Only the adult stage of the first two species was secured and the larval stage of the next two. The last two mentioned genera have not been found in infested lodgepole pine but as they occur in Dm attacked yellow pine and they may be expected to occur in lodgepole, the distinguishing characters of the adult stage are included with those of the first two genera (Plate 1, Figs. 7, 8, 10, 11, and 18).

Counts between June 4 and July 26 of 113 square feet of bark surface from Dm 28 trees showed an average for Phleonomus and Placusa together of 1.2 a square foot, but 63 were counted in 6 square feet in one tree alone. Staphylinid larvae counted ** in the same trees and the same area that the adults were counted showed an average of 0.9 a square foot with a maximum of 40 for 5 square feet of bark surface on one tree. The absence of the larvae of Phleonomus and Placusa and the adults of Tachyporus and Gyrophaena can not be explained.

*Determinations of this and the preceding species by Dr. Boving.
** The two genera together.

As there is small indication that any of these forms are predacious on the larvae of the mountain pine beetle; no detailed description of them will be made, the characters given in the figures on Plate 1 being sufficient to separate them from each other.

An egg of Phleonomus was secured in a rearing vial June 27, 1929. It measured .45 by .22 mm.; was translucent white, and its surface smooth. The larva hatched between June 29 and 30 but as it could not be found several weeks later the larval characters are not known.

Dm larvae placed with Phleonomus adults were not fed on but a larva which had pupated in the vial appeared to have been partly eaten the day following pupation. This is the only instance that occurred and it does not seem reasonable that a beetle of this small size would be capable of piercing the tough cuticle of the beetle larva, nor is it believed that under field conditions they would feed on Dm pupae.

Economic Status

None of the above insects were found to be of importance in the natural control of the mountain pine beetle but they are very numerous. Counts made between June 4 and July 26, 1929, of 113 square feet of bark surface from 23 Dm 28 trees showed for the larvae (all species grouped together) 1.63, and for the adults (all species grouped together) 1.1 per square foot.

PART II

The list beginning on the following page, arranged phylogenetically by orders and families, is the result of a preliminary attempt to record all insects and insect relatives that one may find in a lodgepole pine from the time it has been attacked by the mountain pine beetle to the year following when the brood emerges from the tree. Some of the insects are but incidental but most of them have been attracted by the conditions set up by the beetle, though in many cases similar or equivalent conditions such, for example, as occur in a windfall, do occur without the mountain pine beetle being a factor to these conditions.

The list gives an idea of the biological complexity that soon develops as a result of the beetles' attack on the tree. The probable sequence of invading insects and category into which they would fall is something like this:

First Stage: Early predators such as Medeterus.
Early predacious - saprophagous insects as Lonchaea.

Second Stage: Insects attracted to weakened trees, such as certain Ips, Cerambycids, Buprestids, etc.

Third Stage: Early parasites of Dm as Rhopalicus, the early generation of Coeloides, and parasites of the first two stages.
Late - predacious-saprophagous forms such as Glischrochilus, etc.
Later - predators as clerids.

Fourth Stage: Hyperparasites as Eurytoma.
External bark predators as spiders and ants.

Fifth Stage: Necrophagous, Coprophagous, and Mycetophagous forms such as Neopachygaster.
Later - predators as Xylophagus and Histerids.

Sixth Stage: Late parasites as the main generation of Coeloides.
Later hyperparasites as Ichneumonids and Eurytoma.

Unfortunately, besides the insects which the investigator has undoubtedly overlooked in the study, there are missing from this assembly some fifty odd species for which no determinations have as yet been secured.

Where no mention is made of a stage of a species the stage is not known.

Nematodes ?

Under the bark of trees infested for several months by Dm one can often find hundreds of greyish-white thread-shaped animals less than a millimeter in length. How they are introduced into the tree and what their habits or seasonal history are is not known. There have been no indications that they affect the Dm brood in any way.

Mites

There are several species of mites found under the bark of Dm infested trees. Some may feed on Dm eggs but this has not been determined conclusively. Nothing of the seasonal history or habits has been worked out.

Arachnida
Pseudoscorpionida

Adult

The relation of these interesting crab-like insects to the mountain pine beetle is not known, though they may at times get "rides" from them by clinging to their legs, or under their wing covers, as they do with some other larger insects. Those in lodgepole average between 2 and 3 mm. in length.

Araneida
Adult

Two species of spiders are common on the bark of infested trees. In one instance one was observed to catch a female Medeterus that moved under a bark scale in search of a suitable place for oviposition.

Neuroptera
Chrysopidae?

Adult and Larva

Larvae that probably belong to this family have been collected on the bark of infested trees, and readily feed on Dm larvae when placed in a vial with them. Their habits under field conditions are not known. They pupate in nearly spherical silken cocoons about 4 mm. in diameter. One larva collected July 29, 1929, pupated between August 2 and 3 and emerged between August 20 and 21.

Rhaphidiidae
Rhaphidia sp.

Larva - Plate 5, Fig. 4.
Facies - Head and prothorax dark brown, abdomen a mottled brownish purple. No cerci on terminal segment.
Length - Of 1 larva, 14.5 mm.
Remarks - Found under bark of Dm infested tree, June, 1928.

Hemiptera
Anthocoridae
Triphleps sp.?

Adult -
Facies - Rather small, oval, flattened bug with head and thorax very dark brown. Hemelytra and legs lighter brown. Legs with femora not enlarged.
Length - Of 5 individuals, max. 4.8 mm.; min. 4 mm.; aver. 4.2 mm.; width at base of wings, max. 1.4 mm.; min. 1.1 mm.; aver. 1.2 mm.
Remarks - Adults found in late May and in June, July, and August on Dm infested trees. Another species which is blackish, smaller, and slimmer, and with the anterior and posterior femora swollen is also rather common on Dm infested trees in June, July, and August. Its habits are not known; the former species feeds readily on Dm larvae when placed in a vial with them.

Coleoptera
Histeridae
Isolomalus sp.

Adult - Plate 1, Fig. 9.
Facies - Body very dark brown, nearly black; elytra same as body; antennae and legs but little lighter than body; prothorax and elytra rather evenly punctured, the latter without striae; head reflexed.
Length - Of five individuals, max. 2.3 mm.; min. 2 mm.; av. 2.2 mm.; width at base of elytra, max. 1.22; min. 1 mm.; av. 1.2 mm.
Remarks - Adult rather uncommon under the bark of Dm infested lodgepole. More common in Dm infested yellow pine. Adults found in May, June, and July, and perhaps later, in Dm infested trees.

Platysoma punctigerum Lec.

Adult - Plate 1, Fig. 15.
Facies - Entire body shiny black, elytra shining black; antennae and legs dark reddish-brown.
Length - Of five individuals, max. 3.7 mm.; min. 3.4 mm.; av. 3.5 mm.; width at base of elytra, max. 1.53 mm.; min. 1.4 mm.; av. 1.5 mm.

Larva - Plate 2, Figs. 7 and 7a.
Facies - The body, except for the head and first two thoracic segments, is yellowish creamy white; the head and first thoracic segment are deep brown and heavily sclerotized; the second segment has a smaller area brown and sclerotized; the terminal segment bears a pair of 2-jointed cerci, as in Fig. 7a.
Length - Of mature larva about 9 mm.
Remarks - The adults are first found in late May under the bark of Dm infested trees. They may also occur in infested trees in the fall of the year. This is a rather uncommon species in lodgepole but very common in yellow pine infested by Dm. The size is smaller than those found in California in D. brevicomis trees; there the size is between 4 and 5 mm. (1)

Plegaderus sp.

Adult -
Facies - Body and appendages very dark brown, practically black; dorsal surface rather evenly punctured; pronotum with two lateral swellings and a transverse depression just anterior to middle.
Length - Of one individual 1.4 mm.; width at base of elytra .76 mm.
Remarks - Collected on Dm 28 infested tree, June 22, 1929.

Cantharidae
Cantharis sp.?

Larva - Plate 1, Fig. 13.
Facies - A dark rather mottled larva without cerci and a single ocellus on each side of head.
Length - Of two specimens, probably mature, 10 and 11.5 mm.
Remarks - The larvae were occasionally seen on the bark of Dm infested and abandoned trees in early June. Nothing else is known of their habits. Probably predacious.

Cleridae

All three of the clerids listed here are predacious in both the larval and adult stage on the larvae and adults of the mountain pine beetle, but are not in sufficient numbers to be of economic importance specifically. See Table XXIII for number per square foot.

(1) Struble, G.R. - (loc. cit.)

Type full page

Enoclerus lecontei (Wolc.)(2) (Thanasimus nigriventris Lec)

Adult - Plate 1, Fig. 21.
Facies - Head and thorax black with long grey hairs; elytra greyish at base and tips, with distinct black band across middle; greyish area at tips varies from narrow band to broad one reaching to apex. No black spots in grey area at tips. Legs and abdomen black.
Length - Of nine individuals, max. 7.8; min. 6.0; av. 7.0 mm.
Larva - Plate 5, Fig. 3. The larvae of the three clerids listed here are so similar in appearance as to be practically indistinguishable.
Facies - Pinkish white to purple.
Eggs - " 1.2 - 1.4 mm.; pink in color, white circular band near smaller end". Person.
Remarks - Adults found in August working over bark of lodgepole newly infested with Dm. Probably also found in spring in Dm infested trees.

Thanasimus dubius, Fab.

Adult - Plate 1, Fig. 19.
Facies - Head, anterior part of prothorax, and mid-portion of elytra black; posterior region of prothorax, humeri, and occasionally one small spot on each elytra behind humerus, legs, and abdomen, reddish. (Darkest areas in Fig. 19 represent reddish coloration); posterior portions of elytra greyish and bearing a black spot on each elytron.
Larva -
Length - Of 15 individuals, max. 8.5; min. 5.8; av. 7.0 mm.
Facies - Similar to other clerids.
Remarks - Adults abundant the latter part of May on Dm infested trees. Less common in latter part of July and August on trees newly attacked by Dm. This is the most common of the three clerids inhabiting the beetle-infested trees. Larva of type of Plate 5, Fig. 3. Length of mature larva about 13 mm.

Enoclerus sphegus Fab.

Adult - Plate 1, Fig. 20.
Facies - Head and thorax black, covered with long greyish black hairs, elytra black with wide grey band in mid-portion. Legs black, abdomen red.
Length - Of 8 individuals, max. 12.5; min. 10; av. 11.2 mm.
Larva - Of type of Plate 5, Fig. 3.
Facies - Similar to the other clerid larvae.
Length - Mature larva about 20 mm.

(2) For an excellent study of this species see Person, H.L. "A Study of the Clerid Thanasimus nigriventris Lec. with Notes on other Insect Enemies of the Western Pine Bark Beetle", mss. 1928, Forest Insect Laboratory, Palo Alto, Calif.

Remarks - Adults are found in late May and June working over the bark of Dm infested trees.

Melyridae
Malachius sp.

Larva - Plate 1, Fig. 14.
Facies - Markings as shown in Fig. 14, though often a fine double bar between the two prothoracic spots.
Length - Of one larva 4.9 mm.

Pythidae
Pytho planus? Herbst.

Adult - Plate 5, Fig. 15.
Facies - Entire body, legs, antennae, and elytra uniform dark brown. Form distinctly flattened.
Length - Of seven individuals, max. 15 mm.; min. 9.3 mm.; av. 13 mm.; width at base of elytra, max. 3.8 mm.; min. 2.1 mm.; av. 3.2 mm.
Larva - Plate 2, Fig. 5.
Facies - Whitish-yellow to ivory characters as shown in figure.
Length - Of mature larva, about 25 mm.
Pupa - Plate 2, Fig. 10.
Length - About 12 mm.
Remarks - Adults found in late May and June on Dm infested trees. Larvae found under bark of Dm infested trees, and trees abandoned by the beetle. Pupae found in late July.

Elateridae
Mlater brevis Van Dyke

Adult
Facies - Head, thorax, elytra, and abdomen, brownish-black; outer margins of base of pronotum and humeral region of elytra tinged with reddish-brown; antennae color of head; legs slightly lighter than thorax.
Length - Of one specimen 7.1 mm.; width at base of elytra 2.1 mm.
Remarks - Collected on bark of Dm infested tree May 28, 1929.

Limonius aeger Lec.

Adult
Facies - Entire body dark olive-brown (cologne earth). Antennae color of body; legs light yellowish-brown.
Length - Of one specimen 6.5 mm.; width at base of elytra 1.9 mm.
Remarks - Found June 7, 1929 on Dm infested lodgepole.

Ludius propola (Lec)

Adult
Facies - Head and thorax dull black; elytra reddish-brown, with two darker areas on each elytron; antennae color of pronotum; legs color of elytra; ventral surface of body slightly yellowish to black.
Length - Of two specimens 12.5 mm.; width at base of elytra 3.5 mm.
Remarks - Found on Dm infested trees in May and June.

Ludius aereipennis (Kby)

Adult
Facies - Head and pronotum black; elytra bronze-green; antennae and legs black.
Length - Of one individual 18.5 mm.; width at base of elytra 5.5 mm.
Remarks - A fairly common elaterid found ovipositing on Dm infested trees in June.

Ludius triundulatus (Rand)

Adult
Facies - Head and thorax dull black; elytra reddish-tan, with three wavy brown bands extending across each elytron; antennae and legs black; ventral surface of body black.
Length - Of three individuals, max. 10.5 mm.; min. 10; width at base of elytra 2.8 mm.
Remarks - Found on Dm infested trees in June and July.

Buprestidae
Dicerca tenebrosa Kirby

Adult
Facies - Dorsal surface dark bronzy-black to black; ventral surface of a lighter mottled appearance. Antennae and legs similar in color to under surface. Ridges of elytra interrupted.
Length - Of 5 individuals, max. 19.5 mm.; min. 15 mm.; av. 16.6 mm.; width at base of elytra, max. 6 mm.; min. 4.7 mm.; av. 5.2 mm.
Larva - Of type of Plate 5, Fig. 8.
Remarks - Adults very common in late June and July on Dm infested trees.

Buprestis maculiventris Say var. rusticorum (Kirby)

Adult - Plate 5, Fig. 17.
Facies - Head, thorax, abdomen, antennae, legs and elytra, dark metallic green, almost black. Front of head with markings of red-yellow, or color covering the entire front. Pronotum with markings of red-yellow at anterior, lateral margins; elytra without markings; ventral surface of abdomen with markings of red-yellow on the last three abdominal sternites, that on the last the most pronounced, extending clear across.
Length - Of 4 specimens, max. 22 mm.; min. 17 mm.; av. 20 mm.; width at base of elytra max. 7.4 mm.; min. 5 mm.; av. 6.6 mm.
Larva - Of type Plate 5, Fig. 6.
Remarks - Adult found on Dm infested trees in late July and August.

Buprestis alternans (Lec)

Adult - Plate 5, Fig.16.
Facies - Body, legs, antennae, and elytra dark bronze, nearly black, front of head with slight to prominent markings of red-yellow, pronotum with anterior lateral markings of same color; elytra with 2 to 4 irregular distinct to indistinct paint-like blotches of yellow on each elytron; ventral surface with markings of red-yellow, from indistinct to prominent over both thoracic and abdominal sternites.
Length - Of four individuals, max. 19 mm.; min. 17 mm.; av. 18; width at base of elytra, max. 6 mm.; min. 5.2 mm.; av. 5.6.
Larva - Of type of Plate 5, Fig. 6.
Remarks - Adults found ovipositing on Dm infested trees in July and August.

Melanophila intrusa Horn

Adult
Facies - Entire body and appendages dark bronze; widest part of body slightly beyond the middle of the elytra.
Length - Of one individual 7 mm.; width at base of elytra 2.1 mm.
Remarks - One specimen found on bark of Dm infested tree Aug. 24, 1928.

Chrysobothris breviloba Fall.

Adult
Facies - Dorsal surface of body bronzy dark; ventral surface shiny greenish-bronze; body rather flattened; ridges on elytra irregular.

Length - Of three individuals, max. 11.8 mm.; min. 9.9 mm.; av. 11 mm.; width at base of elytra, max. 3.5 mm.; min. 2.9 mm.; av. 3.3 mm.

Larva - Of type shown in Plate 5, Fig. 8.

Remarks - Found on Dm infested trees in June, July, and August.

Chrysobothris monticola Fall

Adult

Facies - Similar to C. breviloba but larger.

Length - Of 4 individuals, max. 16 mm.; min. 14 mm.; av. 15 mm.

Ostomidae

Temnochila virescens (Fab.) var. chlorodea (Mann)

Adult - Plate 1, Fig. 22.

Facies - Entire body, legs, antennae, and elytra greenish purple, surface finely punctured.

Length - Of two specimens 12.5 and 11.2 mm.; width 3.2 and 3.0 mm., respectively.

Egg -

Facies - "Opaque white, subcylindrical in shape".

Length - "1.8-2.2 mm." Person (loc. cit.)

Larva

Facies - Yellowish white, never pink as the clerid larvae. Sclerotization of second thoracic tergum undivided; (divided with the clerids).

Length - Of mature larva about 24 mm.

Remarks - Adults found in fall and probably spring on Dm infested trees; larvae are found in spring. Predacious but not economically important.

Cucujidae

Laemophloeus angustulus Lec.

Adult - Plate 1, Fig. 14.

Facies - Entire body and all appendages uniform light brown; elytra with slight ridges, body flattened.

Length - Of 5 individuals, max. 2.4 mm.; min. 2.1 mm.; av. 2.3 mm.; width, max. .63 mm.; min. .54 mm.; av. .58 mm.

Remarks - Found all season long under the bark of Dm infested trees.

Cucujus clavipes Favr. var puniceus Mann.

Adult - Plate 5, Fig. 1a.
Facies - Entire body scarlet, basal joints of antennae, femora, and elytra scarlet; remaining joints of antennae and legs darker, generally black; side pieces of meso- and metathorax nearly black. Form very flattened.
Length - Of 5 individuals, max. 17.6 mm.; min. 13.5 mm.; av. 15.9 mm.; width, max. 4.1; min. 3.2; av. 3.8.
Larva - Plate 5, Fig. 1.
Facies - Pale yellow-brown.
Length - Of mature larva about 24 mm.
Pupa - Plate 2, Fig. 12.
Facies - Same as larva.
Length - About 17 mm.
Remarks - A much more common species in Dm infested yellow pine; rarely found in lodgepole. Larva makes a small round cell, without using strips of wood fiber, in which it pupates. Newly transformed adults found during the middle of August.

Lathridiae
Corticaria serrata Payk

Adult
Facies - Small, flattened insect, superficially resembling Lasmophloeus angustulus but relatively broader and sides of pronotum serrate. Entire body, legs, antennae, and elytra uniform light brown.
Length - Of 2 individuals, 1.7 mm. and 1.9 mm.; width at base of elytra .54 max. and .71 mm.
Remarks - The two adults found in the middle of July, 1929, under the bark in the Dm egg galleries of two infested trees.

Colydiidae
Aulonium longum Lec.

Adult - Plate 1, Fig. 6 (Pronotum).
Facies - Elongate, shiny dark to medium brown beetle, superficially resembling Hypophloeus, but pronotum bears a distinct carina near each lateral margin, (See Fig. 6) and between these, two rather pronounced tubercles.
Length - Of 5 individuals, max. 5.7 mm.; min. 5 mm.; av. 5.4 mm.; width at base of elytra, max. 1.6 mm.; min. 1.4 mm.; av. 1.5 mm.

Larva
Facies - Of type of that shown in Plate 2, Fig. 9, but caudal plate rougher and sclerotization of tergum of penultimate segment occupies a greater area -- size generally larger.
Length - Of mature larva about 10 mm.
Remarks - Adults or larvae rarely found under bark of Dm infested lodgepole, but very common under bark of Dm infested yellow pine.

Lasconotus n.sp.

Adult
Facies - Resembles L. pertemuis in general shape and in color but is smaller; the pronotum lacks the pronounced foveae on the sides and its width is nearly that of its length.
Length - Of 1 individual, 2.5 mm.; width at base of elytra .7 mm.
Remarks - Adults have been found under the bark of Dm infested trees in May and August.

Lasconotus pertemuis Csy

Adult
Facies - General appearance somewhat like that of L. complex, Plate 1, Fig. 5, but pronotum bears no acute ridges; instead pronotum has one rather large fovea in center and four smaller ones at each of the corners. Ridges on elytra not as pronounced; body relatively more slender than L. complex. Color, dark brown.
Length - Of 5 specimens, max. 3.2 mm.; min. 3.1 mm.; av. 3.2 mm.; width at base of elytra, max. .81 mm.; min. .73 mm.; av. .78 mm.
Remarks - Found under the bark of Dm infested trees from May to September.

Melandryidae
Xylita laevigata (Hellw.)

Adult
Facies - Head and pronotum dull black; elytra dark brown to nearly black; legs and antennae dark brown.
Length - Of 4 individuals, max. 7.5 mm.; min. 6 mm.; av. 6.8 mm.; width at base of elytra, max. 2 mm.; min. 1.4 mm.; av. 1.8 mm.
Remarks - Found on the bark of infested trees from late May into August.

Dent Type
any here

Scotochroa basalis Lec.

Adult - Similar to preceding species in shape and size but elytra black. Middle coxae separated by mesosternum; not contiguous as in Xylita. Found in conjunction with Xylita.

Tenebrionidae
Hyponhlocus n. sp.?

Adult - Plate 1, Fig. 2.
Facies - Head, thorax, and ventral surface of abdomen dark brown; elytra reddish-brown; legs and antennae lighter brown.
Length - Of 4 individuals, max. 3.1 mm.; min. 2.8 mm.; av. 2.9 mm.; width at base of elytra, max. 1 mm.; min. .8 mm.; av..9 mm.
Remarks - Found under the bark in the egg galleries of Dm infested trees.

Bius estriatus Lec.

Adult
Facies - Entire body, legs, antennae, and elytra dark reddish-black; pronotum, antennae, and legs, generally a shade lighter than elytra; surface smooth, no distinct markings.
Length - Of 5 individuals, max. 7 mm.; min. 5 mm.; av. 6.3 mm.; width at base of elytra, max. 2.0 mm.; min. 1.2 mm.; av. 1.7 mm.
Remarks - Adults found under bark of Dm trees in May, June, July, and August, and two years after attack.

Cerambycidae
Spondylis upiformis Mann.

Adult - Plate 5, Fig. 10.
Facies - Body, legs, and antennae shiny black; surface not smooth. Prothorax widest anterior to middle; mandibles prominent.
Length - Of 6 individuals, max. 17 mm.; min. 10 mm.; av. 13.9 mm.; width at base of elytra, max. 4.5 mm.; min. 2.6 mm.; av. 3.8 mm.
Remarks - Common on Dm infested trees in June.

Asemum atrum Esch.

Adult - Plate 5, Fig. 8.
Facies - Head, thorax, abdomen, legs, and antennae black to blackish; elytra uniformly black or brown; prothorax widest at about middle; mandibles indistinct.

Asemum atrum Esch.

Length - Of 4 individuals, max. 17 mm.; min. 12.5 mm.; av. 16 mm.; width at base of elytra, max. 5.0 mm.; min. 3.6 mm.; av. 4.4 mm.

Egg -

Facies - Opaque yellowish white.

Length - Of 3 eggs laid May 25, 1929: 1.75 mm. (average); oval.

Remarks - Adults most common in July on Dm infested trees.

Nothorhina aspera Lec.

Adult - Similar in general appearance to Asemum atrum but considerably longer in proportion.

Facies - Dark brown or nearly black; prothorax the color of the elytra.

Length - Of 2 individuals 20 mm.; width at base of elytra 4.2 mm.; and 4.8 mm. respectively.

Remarks - Found in the latter part of August on newly attacked tree.

Anoplodera aspera (Lec)

Adult

Facies - Head, thorax, abdomen, and elytra dull black; antennae and legs black.

Length - Of 7 specimens, max. 13.5 mm.; min. 9.5 mm.; av. 12.2 mm.; width at base of elytra, max. 4.5; min. 2.6; av. 3.6 mm.

Remarks - Found on bark of Dm infested trees in July.

Large black Lepturinid

Adult - Plate 5, Fig. 10.

Facies - Body, legs, and antennae entirely black; elytra slightly shining; surface rougher towards bases.

Length - Of 4 individuals, max. 19 mm.; min. 18.5; av. 19 mm.; width at base of elytra, max. 6.4 mm.; min. 6.0 mm.; av. 6.2 mm.

Remarks - One collected ovipositing on Dm infested tree June 22, 1929, others on Dm infested trees, July 1, 1929.

Anthophilax mirifica Bland.

Adult - Plate 5, Fig. 12.

Facies - Head, thorax, legs, and antennae black; abdomen pale red; elytra, brick red with basal and apical areas black.

Length - Three specimens, max. 15 mm.; min. 14; av. 4.8 mm.; width at base of elytra, max. 4.6; min. 4.3; av. 4.5 mm.

Remarks - Adults found on Dm infested trees in June.

Stenocoris lineatum (Oliv.) (Rhagium)

Adult -
Facies - Head, thorax, abdomen, and elytra, grey; elytra marked with small rusty areas and three distinct longitudinal ribs on each elytron; antennae and legs grey.
Length - Of 6 specimens, max. 16.5 mm.; min. 13 mm.; av. 14.9 mm.; width at base of elytra, max. 4.5 mm.; min. 4.0 mm.; av. 4.1 mm.

Larva -
Facies - Yellowish white to ivory, body flattened dorso-ventrally.
Length - "Mature larva 25-30 mm." Hess.

Pupa - Plate 5, Fig. 5.
Length - 14.5 mm.

Remarks - The adults are found on the bark of Dm infested trees the latter part of May and early June. The cerambycid larvae that bear legs and that are commonly found in lodgepole, belong to this species. The pupa was collected the last day of July, 1929.

Xylotrechus sp.

Adult - Plate 5, Fig. 11.
Facies - Head, thorax, abdomen, and wing covers dark brownish-black; markings as shown in figure yellow to white, posterior-ventral margins of abdominal segments marked with same color as markings of elytra and pronotum.
Length - Of 2 individuals, 15 and 16 mm.; width at base of elytra 5 mm. for both.
Remarks - Found in August on newly attacked trees.

Monochamus oregonensis Lec.

Adult
Facies - Entire body blackish bronze; elytra slightly specked with white.
Length - Of 5 individuals, max. 22 mm.; min. 15 mm.; av. 18 mm.; width at base of elytra, max. 6.5 mm.; min. 4.0 mm.; av. 5.3 mm.

Larva -
Facies - Ivory white to yellowish, form similar to that of larva; Plate 5, Fig. 7.
Length - Of mature larva about 38 mm.
Remarks - Adults common in late July and August on newly infested trees. The larvae at times are beneficial by reason of feeding in the cambium and reducing the food supply of the beetle brood. Probably also destroys brood directly by including the beetle larvae in its diet as it feeds on the cambium. Two other species resemble the adult in

size and general appearance. Monochamus maculosus has black spots composed of very short hairs on elytra. M. scutellatus has no white on elytra.

Hyperplatys ?

Adult - Plate 5, Fig. 14.
Facies - Body mottled grey-black; lighter towards the base of the elytra.
Length - Of 1 individual 6.2 mm.; width at base of elytra 2.4 mm.
Remarks - Reared from Dm infested tree. Tree attacked August, 1928. Tree caged May 3, 1929; beetle collected dead August 1, 1929.

Acanthocinus obliquus Lec.?

Adult - Plate 5, Fig. 13.
Facies - Head, thorax, and abdomen greyish-black; elytra mottled grey-black; legs and antennae with grey and black bands.
Length - (To end of elytra) of 5 individuals, max. 13 mm.; min. 9.5 mm.; av. 4.2; width at base of elytra, max. 3.8 mm.; min. 3.0 mm.; av. 3.4 mm.
Larva - Of type of Plate 5, Fig. 7.
Remarks - Found chiefly in July on Dm infested trees.

Diptera
Limnobiidae
Gnophomyia tristissima O. S.

Adult - Wing, Plate 3, Fig. 13.
Facies - A rather large long-legged fly of "crane-fly" type. Body sooty black.
Length - 6-8 mm.
Egg - Plate 3, Fig. 4.
Facies - Dark dirty grey with longitudinal ridges or flutes marking the surface. Laid under the bark in the egg galleries.
Length - Of 2 eggs, 1.8 and 1.7 mm.
Larva - Plate 3, Figs. 10 and 21.
Facies - Elongate "greenish" brown larva with prominent cephalopharyngeal sclerites and characteristic terminal segment as shown in Fig. 21.
Length - Of mature larva about 8 mm.

Pupa - Plate 3, Figs. 19 and 25.
Facies - Elongate; yellow-white in color. Fig. 25 shows the character of the terminal segment of the male pupa; compare with Fig. 19. Emergence from pupal stage of those collected occurred in late June.
Length - 9-10 mm.
Remarks - Adults found ovipositing chiefly on Ips-infested trees but occasionally on moist bases of Dm-infested trees.

Sciaridae
Sciara sp.

Adult - Plate 3, Fig. 17 (wing).
Facies - A small gnat-like insect with thorax black and shiny; wing veination as shown in Fig. 17.
Length - Between 3 and 4 mm.
Larva - Plate 3, Fig. 12.
Facies - Elongate, footless; head capsule black or very dark brown; rest of body yellow-white to occasionally orange.
Length - Of mature larvae about 7 mm.
Pupa - Plate 3, Fig. 23.
Facies - Yellow-white; form as shown in Fig. 23.
Length - About 4 mm.
Remarks - Adults rather common on bark of Dm-infested trees in early June; larvae are found chiefly in Dm trees after the beetle brood has emerged; occur only where the bark is moist or wet. Feeds supposedly on decaying organic matter; not predacious. Counts made between June 4 and July 26, 1929, of 113 square feet of bark surface from 23 trees showed .28 larvae per square foot.

Ceratopogonidae
Forcipomyia squamipes Coq.?

Adult - Plate 3, Fig. 15 (wing).
Facies - Gnat-like greyish-black body with many hairs.
Length - About 2.5 - 3 mm.
Larva - Plate 3, Fig. 18.
Facies - Elongate yellowish-white maggot with distinct head capsule. First thoracic segment bearing a pair of pseudopods; dorsum covered with long hairs as shown in figure.
Length - Mature larva about 3.5 mm.
Pupa - Plate 3, Fig. 24.
Facies - Yellowish-white in color. The larval skin almost invariably adheres to the pupa as shown in Fig. 24.
Length - About 2.6 mm.

Diptera
Cecidomyidae

Adult - Plate 3, Fig. 16 (wing).
Facies - Small blackish, gnat-like insect with a few short hairs on thorax; best distinguished from the two previous described families by the characters of the wing.
Length - About 2 mm.
Egg -
Facies - Color reddish-yellow; surface smooth with no markings.
Length - Average of 13, .3 mm.; width, .1 mm.
Larva - Plate 3, Fig. 11.
Facies - Elongate, legless maggot, varying in color from ivory white to pinkish orange. Head very indistinct. Spatula on ventral surface being only darkened part visible.
Length - Of mature larva about 4 mm.
Pupa - Plate 3, Fig. 20.
Facies - Yellowish white in color; characters as shown in figure.
Length - About 3 mm.
Remarks - The larvae are very common under the bark of Dm-attacked trees six weeks after the attack and are found wherever the bark remains sufficiently moist, for at least a year. Of no economic importance. Counts made between June 4 and July 26, 1929, of 113 square feet of bark surface from 23 Dm 28 trees showed an average of 1.9 per square foot.

Stratiomyidae
Neopachygaster sp.

Adult - Plate 3, Fig. 28.
Facies - Body blue-black, practically black; eyes cinnamon; antennae dark to cinnamon; coxae and femora black; tibiae occasionally cinnamon; tarsi always light.
Length - From about 3 - 3.5 mm.
Larva - Plate 3, Fig. 1.
Facies - Brown-grey in color; bristles prominent; only larva with long bristles on both dorsal and ventral surface; cuticula with shagreened appearance.
Length - Of mature larva about 6 mm.
Remarks - Adults reared from larvae in late May and June. Adults found on bark of Dm-infested trees in early July. Pupation occurs within the larval skin which does not become indurated. Supposedly predacious at times on dipterous larvae. See page 37.

Hymenoptera
Tenthridinidae
Amauronematis probably borealis Marl. and oregonensis, Marl.

Adult - Adults belonging to this genus have been reared from cocoons collected in the egg galleries of Dm in the spring of the year. They probably crawl in by means of the beetle aeration holes in search of a place for hibernation. Adults emerged from cocoons May 20, 1929.
Facies - Body generally greenish in color; abdomen sessile; wings always with many veins.
Length - Between 6 and 9 mm.

Siricidae
Genus not known

Adult - Plate 5, Figs. 18 and 18a.
Facies - Head, thorax, and abdomen black; thorax with whitish band on each side of prothorax, which is prolonged to make a spot on the head; terga of abdomen with reddish areas at anterior margins. Head and thorax roughened; abdomen smooth; antennae color of head; all joints of all legs straw color. Bases of ovipositor sheaths straw color.
Length - Of 3 individuals exclusive of ovipositor, 27.5 mm., 25.5 mm., and 15.5 mm. Length of ovipositors beyond end of abdomen, 20 mm.; 20 mm., and 10.5 mm., respectively; width at prothorax 4 mm., 3.8 mm., and 2.1 mm. respectively.
Remarks - Found ovipositing on infested trees in late July and August.

Siricidae
Genus not known

Adult - Plate 5, Fig. 19.
Facies - Entire body, legs, and antennae, gun-metal blue-black; wings smoky. Head and thorax roughened; abdomen smooth.
Length - Of 3 exclusive of ovipositor: 24, 22.5, and 17 mm.; ovipositors projected beyond end of abdomen, 3, 3, and 2.4 mm. respectively; width, 4.5, 4.2, and 3.1 mm. respectively.
Remarks - Found ovipositing in newly-infested Dm trees in late July and August.

Hymenoptera
Formicidae

Several species of ants have been collected on the bark; not infrequently they have been observed attempting to catch parasites. In one instance one was found running down a tree trunk with a predacious beetle larva in its mandibles.

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Explanation of Plates

The number following the genus or species, or on the other plates the number following the stage, is the length in millimeters of the specimens from which the drawings were made; the figures in parenthesis after the family name refer to the plate and number respectively, which show drawings of another stage of the species mentioned, and the Roman numeral and arabic number which follow the parenthesized figures refer to the part and page to which further reference is made, such as color, distinctive characters, and habits. Drawings made by the aid of the camera lucida. Photographs of drawings made by H. J. Rust.

Adult Coleoptera - Plate 1

Fig. 1	Rhizophagus procerus Csy -	4.2	Rhizophagidae (2-4)	I	49
2	Hypophloeus n. sp.?	3.6	Tenebrionidae	II	68
3	" parallelus Melsh	4.0	" (2-8)	I	44
4	" n. sp.?	3.3	"	II	68
5	Lasconotus complex Lec.	4.2	Colydiidae (2-9)	I	50
6	Aulonium longum Lec. (Pronotum 1.5)		"	II	66
7	Phloeonomus pusillus Grav. (Pronotum 1.5)		Staphylinidae (2-2) (see also Fig. 18)	I	55
7a	" " " Terminal segment of maxillary palpus.				
8	Mlegusis sp.		Staphylinidae	I	55
8a	" " Terminal segment of maxillary palpus				
9	Isolomalus sp.?	2	Histeridae	II	59
10	Placusa sp.		Staphylinidae	I	55
10a	" " Terminal segment of maxillary palpus.				
11	Leptusa sp.		Staphylinidae	I	55
11a	" " " " " "		palpus		
12	Quedius longipennis Mann (pronotum)		Staphylinidae	I	55
13	Epurea linearis Mäkl.	3.6	Nitidulidae (2-6)	I	48
14	Lacmophloeus angustulus Lec.	2.0	Cucujidae	II	65
15	Platysoma puntigerum Lec.	3.9	Histeridae (2-7)	II	59
16	Nudobius cephalus (Say)?	10.6	Staphylinidae (2-11)	I	53
17	Glischrochilus vittatus (Say)	4.7	Nitidulidae (2-1)	I	40
18	Phloeonomus pusillus Grav.	2.2	Staphylinidae (2-2)	I	55
19	Thanasimus dubius Lec.	6.2	Cleridae (5-3)	II	61
	The darkest areas indicate red, the lightest, grey, and the medium shade, grey-black or black.				
20	Enoclerus sphegus Fab.	9.5	Cleridae (5-3)	II	61
	The lighter shade indicates a grey band which is generally wider and rather variable in width.				
21	Enoclerus lecontei (Wolc.)	7	Cleridae (5-3)	II	61
	The lighter areas indicate grey; the band towards the apex of the elytra is generally wider and attains the tip.				
22	Temnochila virescens (Fab.) var. chlorodea (Mann) 11		Ostomidea (5-2 and 4)	II	65

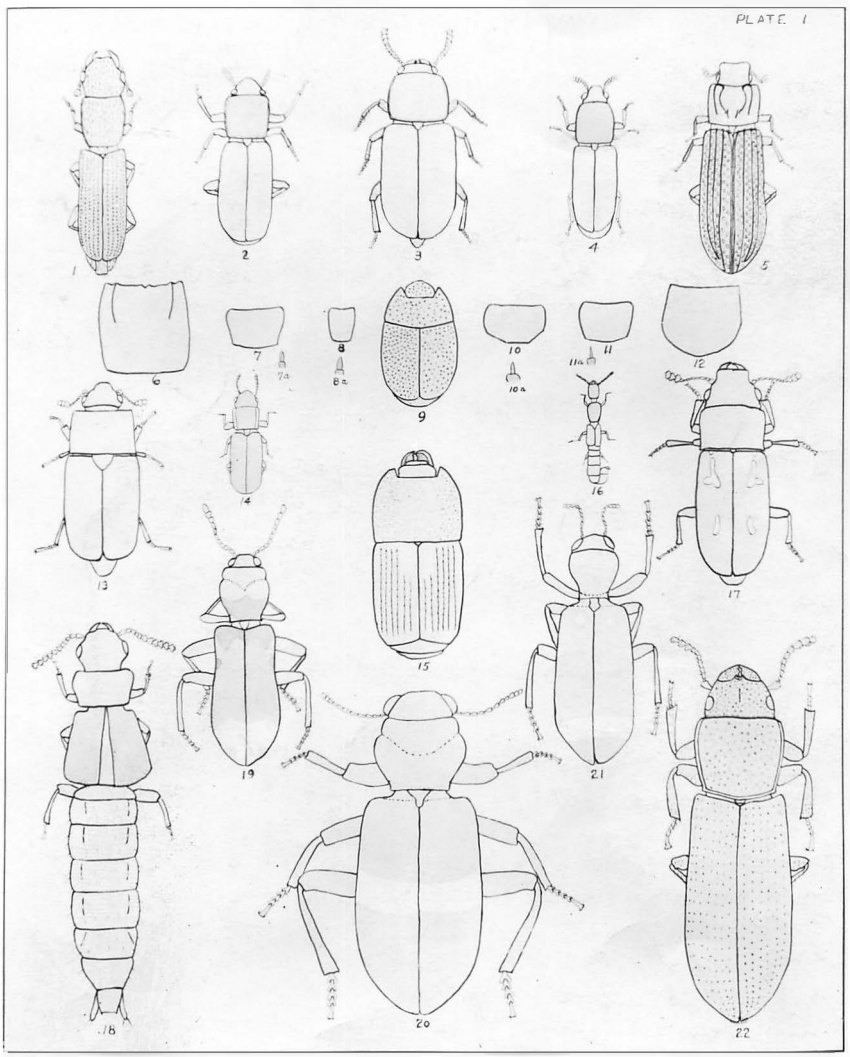
PLATE I
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Coleopterous Larvae and Pupae - Plate 2 Copy

Fig. 1	Glischrochilus vittatus (Say)	Larva 9.5 Nitidulidae (1-17)	I	40
1a	" "	Egg	I	
1b	" "	Arrangement of ocelli		
1c	" "	Detail of cercus.		
2	Phloeonomus pusillus Grav.	Egg Staphylinidae	I	55
3	Tachyporus sp.	Larva 2.7	I	55
4	Rhizophagus probably procerus Csy	" 5.4 Rhizophagidae (1-1)	I	49
4a	" procerus Csy	Egg .8	I	50
4b	" probably procerus Csy	Detail of terminal segment		
4c	" " " "	Arrangement of ocelli		
5	Pytho probably planus Herbst?	Larva 9; for pupa see Fig.10(5-15)	II	62
5a	" " " "	Arrangement of ocelli		
6	Epurea linearis Mäkl.	Larva 4.5 Nitidulidae (1-13)	I	48
6a	" " "	Arrangement of ocelli		
7	Platysoma punctigerum Lec.	Larva; detail of head and first 2 thoracic segments (1-15)	II	59
7a	" "	Detail of terminal segment		
8	Hypophloeus parallus Melsh.	Larva 6.3 Tenebrionidae (1-3)	I	44
8a	" " "	Egg .8		
8b	" " "	Arrangement of ocelli		
9	Lasconotus complex Lec.	Larva 5.5 Colydiidae (1-5)	I	50
9a	" "	Egg	I	
9b	" "	Detail of cercus		
9c	" "	Arrangement of ocelli		
10	Pytho probably planus Herbst.	Pupa 12 for larva see Fig. 5 (5-15)	II	62
11	Nudobius probably cephalus (Say)	Larva 7.5 (1-16)	I	53
12	Cucujus clavipes Fab. var puniceus Mann.	Pupa 17 (5-1 and 1a)	II	66
13	Cantharis sp. total length of larva 11.5 detail of head and thoracic segments 4.3		II	60
14	Malachius sp.	Larva 4.9	II	62

Diptera - Plate 3

Fig. 1	Neopachygaster sp.	Larva 6.3	Stratiomyidae	II	73
28	" sp.	Adult 2.5			
2	Lonchaea viridana Meigen	Egg .8	Lonchaeidae	I	36
6	" " "	Larva 7		I	
27	" " "	Adult 4.1		I	
32	" " "	Pupa 4.5		I	
3	Medeterus aldrichi Wheeler	Egg .8	Dolichopodidae	I	28
9	" " "	Larva 6.5		I	
22	" " "	" terminal segment dorsal view			
26	" " "	Adult 4			
29	" " "	Pupa 4			
4	Gnophomyia tristissima O.S.	Egg .56	Limnobiidae	II	71
10	" " "	Larva 9		II	
13	" " "	Wing of adult		II	
19	" " "	Pupa female 8.9		II	
21	" " "	Apical segment of larva caudal view, after Mallock			
25	" " "	Pupa male, apex of abdomen		II	
5	Xylophagus abdominalis Loew	Egg 1.5	Xylophagidae	I	33
7	" " "	First instar larva (lateral view)		I	
8	" " "	Mature larva (dorsal view) after Greene		I	
30	" " "	Adult 12		I	
31	" " "	Pupa 16 (lateral view)		I	
11	Cecidomyidae	Ventral view showing detail of spatula			
		Larva 4	Cecidomyidae	II	73
16	"	Wing of adult 2		II	
20	"	Pupa 2.7		II	
12	Sciara	Larva 4.1	Sciaridae	II	72
17	"	Wing 2.7			
23	"	Pupa 4.0		II	
14	Cecidomyidae	Undetermined species distinct from #11 and showing one segment of body and striate appearance of cuticula.			
14a	"	Terminal segment of same species showing caudal spines.			
15	Forcipomyia probably squamipes Coq.	Wing 1.9	Ceratopogonidae	II	72
18	"	Larva 3.4, dorsal view showing detail of tips of dorsal hairs.			
18a	"	Larva lateral view showing detail of pseudopod.			
18b	"	Larva ventral view of terminal segment showing ambulatory hooks.			
24	"	Pupa 2.6 showing cast larval skin which almost invariably adheres to caudal end of pupa.			

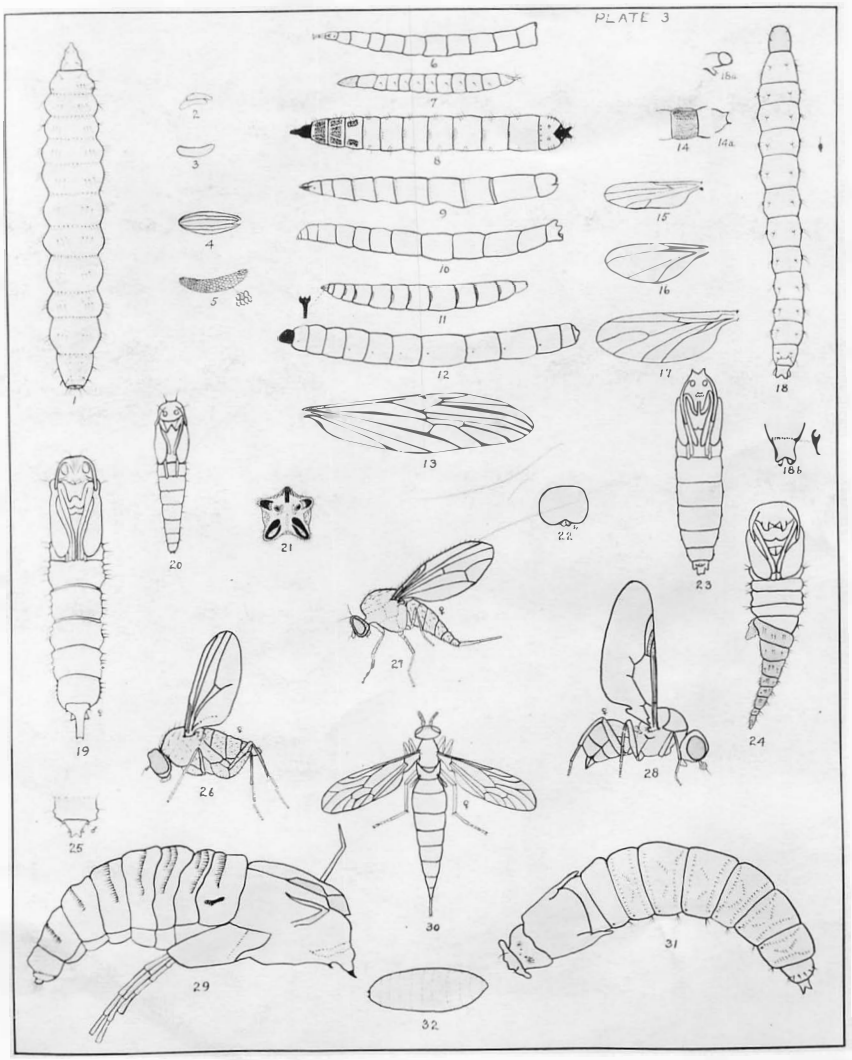
PLATE 3
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Hymenoptera - Plate 4

Fig. 1	Coeloides sp.	Larva nearly mature 3.8 Braconidae	I	3	
1a	" "	Head capsule; mn mandibles	I		
1b	" "	Egg 1.1	I		
1c	" "	First instar larva 1.3	I		
1d	" "	Cocoon 4.9	I		
1e	" "	Adult female. 7 The antenna is shown foreshortened; 2c, 2nd cubital; st stigma			
2	Rhopalicus pulchripennis Cwfd.	Larva 3.3 Pteromalidae	I	24	
2a	" " "	Head capsule	I		
2b	" " "	Pupa 2.9	I		
2c	" " "	Egg	I		
2d	" " "	Adult female 4.2			
3	Pachyceras eccoptogasteri Ratz.	Larva 4.1	I	26	
3a	" "	Head capsule	I		
3b	" "	Pupa 3.2	I		
3c	" "	Adult female	I		
3d	" "	Antenna	I		
4	Eurytoma pissodis Gir.	Larva 4.1 Eurytomidae	I	20	
4a	" " "	Head capsule	I		
4b	" " "	Egg .6	I		
4c	" " "	Pupa 4.3	I		
4d	" " "	Adult female 5.0	I		
4e	" " "	Antenna, female			
4f	" " "	" male			
4g	" " "	Abdomen of male	I		
5	Cecidostiba dendroctoni Ash	Larva 5.5 Pteromalidae	I	22	
5a	" "	Head capsule	I		
5b	" "	Pupa 5.4	I		
5c	" "	Adult female 6.5			
6	Heydenia hubbardi Ashm.	Adult female 3.2 Chalcididae			
6a	" "	Antenna of female			
6b	" "	Abdomen of male			
7	Dendrosoter n. sp.	Adult female 4.5 Braconidae	I	14	
7a	" "	Antenna of female			
7b	" "	Egg	I		

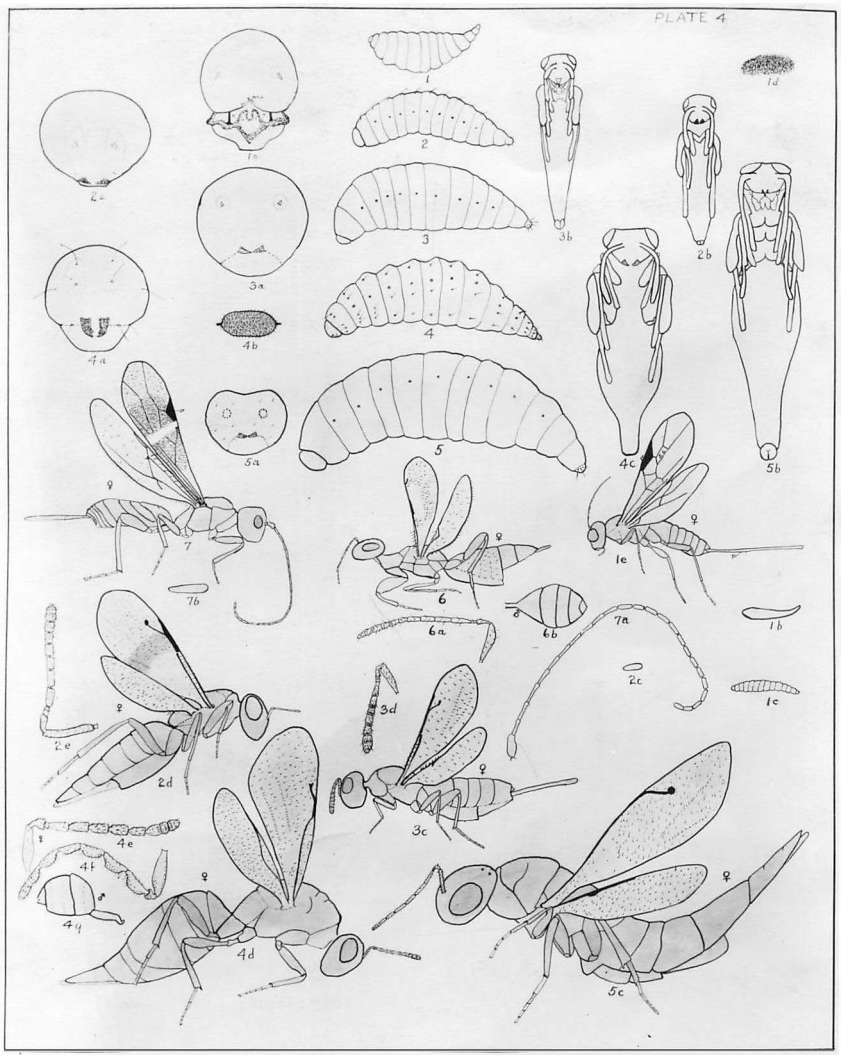
PLATE 4
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7a
7b

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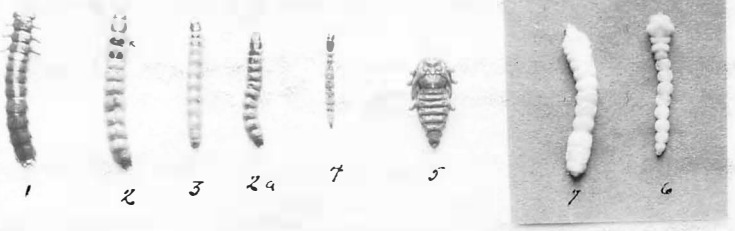
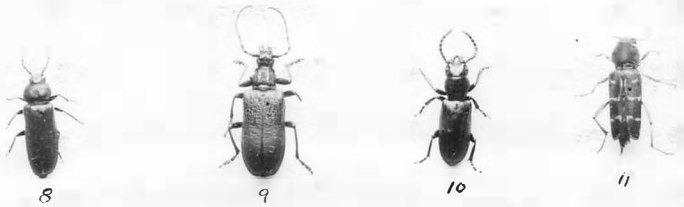
Miscellaneous Coleoptera, Hymenoptera and Neuroptera - Plate 5

Fig. 1	Cucujus clavipes Fab. var puniceus Mann.	Larva 24	Cucujidae (2-12)	II	66
1a	" " " " " "	Adult 16.5	" (2-12)		
2	Temnochila virescens (Fab.) var chlorodea(Mann)	Larva 24	Ostomidea (1-22)	II	65
	Arrow points to undivided area of darkening on 2nd thoracic segment.				
2a	Temnochila virescens var chlorodea	Larva 18			
3	Clerid larva 19.5 type for Thanasimus and Enoclerus.		Cleridae(1-19, 20 and 25)	II	61
	Arrow points to divided areas of darkening on 2nd thoracic segment.				
4	Rhaphidia? sp.	Larva 14.5	Neuroptera . Rhaphididae	II	59
5	Stenocorus lineatum (Oliv.)	Pupa 14.5	Cerambycidae	II	
6	Buprestid larva 20.5 mm. type for Figs. 16 and 17		Buprestidae	II	
7	Cerambycid larva 22.5 " " Figs. 9-14 incl.		Cerambycidae	II	
8	Asemum atrum Lec.	Adult 15	Cerambycidae	II	68
9	? ?	" 18.5	"	II	68
10	Spondylis upiformis Mann.	" 14	"	II	68
11	Xylotrechus sp.	" 15	"	II	70
12	Anthophilax mirifica Bland.	" 14.8	"	II	69
13	Acanthocinus obliquus Lec.?	" 9.5	"	II	71
14	Hyperplatys sp.?	" 6.2	"	II	71
15	Pytho probably planus Herbst.	Adult 13.5	Pythidae (1-5 and 10)	II	
16	Buprestis alternans (Lec.)	" 19	Buprestidae	II	62
17	" maculiventris Say var. rusticorum (Kby)	Adult 21	Buprestidae	II	64
18	Sircidae	Adult 15.5	Hymenoptera	II	
18a	"	Adult 27.5, same species as 18 but showing diversity in size.		II	
19	"	Adult 22.5		II	

PLATE 5





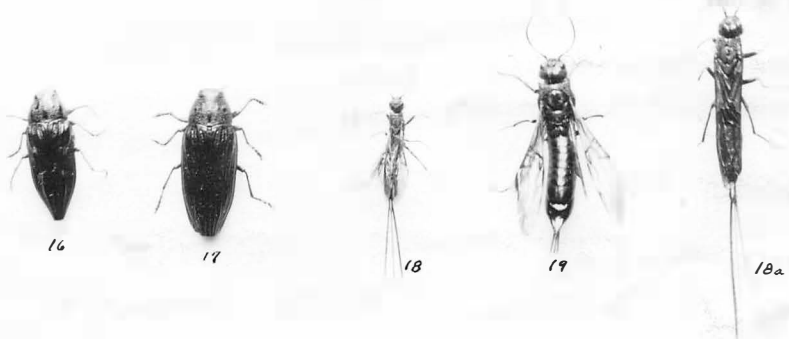
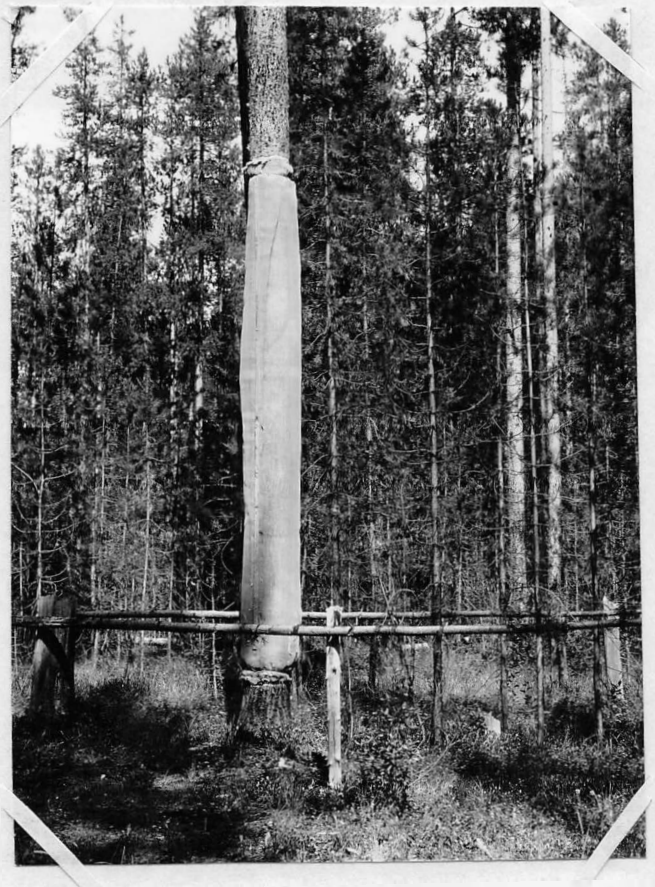


Plate 6



Type of cage used in an experiment in an attempt to determine the amount of Dm brood killed by the larvae of Medeterus aldrichi Wh. Tree 12" D.B.H. Cage 10 feet long of #24 wire screen.

Explanation of Tables XXII and XXIII

All data were secured at Sula, Montana, except data in the fourth row of Table XXII which were secured in the region of Wisdom, Montana, just across (east of) the Continental Divide.

The character of the infestation mentioned in column 1 was determined by the length of time trees had been killed on the area in which the examinations were made. The old infestation represents an area in which many trees had been killed previous to 1926; the main infestation in which many trees had been killed during 1926 and 1927, and the advanced infestation in which most of the trees had been killed during 1928 and 1929.

The percentage of parasitism is figured on the actual Dm brood present at the time the parasite counts were made*. Though the number of parasites per square foot increases but little after the last week of June, the per cent parasitism apparently increases due to the reduction of pupae and new adults by causes other than parasites. Because of the wide variations between the figures which made up the average per cent parasitism the data given in Table XXII should only be considered indicative.

No Coeloides sp. parasitism occurs in the average period of May 29, Table XXIII, as the first parasite eggs were not found until the first week in June.

The per cent "predatorism" is not a good criterion for the value of the insect concerned as one does not know how much brood is destroyed by a single predator.

The chalcid larvae per square foot are figured exclusive of Eurytoma pissodis larvae.

The larvae of the clerids Thanasimus dubius, Enoclerus sphegus and Enoclerus lecontei are all grouped under the one heading "clerids".

* Patterson, in his report of March, 1928 (Palo Alto Station) on the Mountain Pine Beetle in Southern Oregon, mentions a Coeloides sp. which parasitized about 18 per cent of the Dm brood. However, as he figured the number of parasites against the number of Dm pupal cells, and made no mention of the age of the infestation, the figures he secured have a different value than those shown in the opposite tables.

Table XXII

Season of 1928

Average Period of Examination	No. Sq.Ft. Examined	Larvae per Sq.Ft. Coeloides:	Dm	Per Cent Parasitized
Old infestation July 6	161	5.1	11	31.7
Main infestation July 13	694	7.3	27	21.3
Advanced infestation June 21	207	2.5	67	3.6
Advanced infestation, Big Hole July 12	218	3.2	28	10.3

Table XXIII

Season of 1929

Av.Period of Examination	No.Sq. Ft. Examined	Larvae per Square Foot: Dm Brood	Coel.	% Parasitism	Chalcids	% Parasitism	Med.	% Med.	Clerids	% Clerids
Main-advanced infestation										
May 29	70	65	None	None	.23	.35	1.7	2.6	.31	.48
June 20	111	30			.09	.03	1.8	4.5	.17	.56
	90*	32	4.6	12.4						
July 19	442	21			.27	1.3	.42	2.03	.19	.92
	216*	23	40	14.7						

* Based on 1/4 sq.ft. examinations - figures above based on sq. ft. examinations.

CHART I
FIRST YEAR
July
Aug
Sept
Oct to April
May
June
SECOND YEAR
July
Aug
Sept
Oct to April
May
June
THIRD YEAR
Eggs
Larvae
Larvae
Larvae - Spincocoons - Larvae within cocoons
Larvae within cocoons
Pupae
Emerge
Larvae - Pupae
Pupae - New adults - Emerge
Larvae - Spincocoons
Larvae within cocoons
Pupae - Emerge
Three Year Chart Showing Seasonal History OF Coeloides Generations in ONE Tree After It Has Been Attacked by Dendroctonus monticolae
Read Clockwise Beginning July of First Year
Outer Arc = D. monticolae Generation
Middle Arc = Early Generation of Coeloides
Inner Arc = Main Generation of Coeloides